TRANSMITTAL

PROJECT:	Stapleton Northfield Campus Phase 1
DPS PROJECT NO.:	PP2037
LOA PROJECT NO:	1102
DATE:	18 August 2014
TO:	GE Johnson Construction Co. 5500 N. Central Park Blvd. Denver, CO 80239
ATTN.:	Tyler Clements, Chad Wilson

We are sending you: Submittal #0054-SLC BP2 Reviewed Sent by: Teena Taylor

	Drawings		Mail		Printer
X	Shop Drawings		Air Mail		Hand
	Specifications		Registered Mail		Fax
	Samples		Delivery		Other
	Reports		Express Service	X	PDF
	Other		FedEX Ground		

SHOP DRAWING NO.	DATE	COPIES	DESCRIPTION
0054-235200-00	08-18-2014	1	23 52 00 Boilers Submittal

Shop Drawings reviewed as follows:

	No Exceptions Taken		Revise and Resubmit	X	Reviewed
X	Exceptions as Noted		For Review & Comment		Submit Specified Item

DPS Comments:Approved

LOA Architecture, P.C.
480 East 20th Ave.
Denver, Colorado 80205
Tel (303) 863-9080
Fax (303) 863-9130

CC:
SENT BY: Tim Holk

GE JOHNSON CONSTRUCTION COMPANY
CONTRACTOR OF CHOICE™

Submittal Transmittal

Detailed, Grouped by Each Number, Submittal Transmittal Number is Package Number

Denver Public Schools
Denver, CO

Project # 1405
Tel: 303.221.1249 Fax: 303.221.1989

G. E. Johnson Construction Company, Inc.

Date: 7/18/2014 **Submittal Transmittal Number: 0054 - 23 52 00 - 0**

Transmitted To:
Tim Habben
LOA Architecture PC

480 East 20th Avenue
Denver, CO 80205
Tel: 303.863.9080

Transmitted By:
Tyler Clements
G. E. Johnson Construction Company, Inc.
25 North Cascade Avenue, Suite 400
Colorado Springs, CO 80903
Tel: 719.473.5321
Fax: 719.473.5324

Qty	Description	Due Date	Package Action
1	SLC (BP#2) - Condensing Boilers	8/1/2014	

Transmitted For	Delivered Via	Tracking Number
Approval	Email	

Items	Qty	Specification #:	Description	Type	Item Action
0001	1	23 52 00-1.03A-000 SLC	Boilers - Product Data	Product Data	
	Notes				
0002	1	23 52 00-1.03B-000 SLC	Boilers - Efficiency Curves	Information	
	Notes				
0003	1	23 52 00-1.03C-000 SLC	Boilers - Pressure Drop Curves	Information	
	Notes				
0004	1	23 52 00-1.03D-000 SLC	Boilers - Shop Drawing	Shop Drawings	
	Notes				
0005	1	23 52 00-1.03E-000 SLC	Boilers - Test Report	Test Reports	
	Notes				
0006	1	23 52 00-1.03F-000 SLC	Boilers - Field Test Report	Test Reports	
	Notes				

Cc:	Company Name	Contact Name	Copies	Notes
	Denver Public Schools	Sara Schesser	1	
	G. E. Johnson Construction Company, Inc.	Dave Pastier	1	
	LOA Architecture PC	Greg Allen	1	
	LOA Architecture PC	Teena Taylor	1	

Remarks

Tim,
Submittal #54 has been uploaded to Crush.

Signature **Signed Date**

M-E Engineers, Inc.
10055 west 43rd avenue / wheat ridge / co 80033
t. 303.421.6655 / f. 303.421.0331
www.me-engineers.com

SUBMITTAL REVIEW FORM
Stapleton Northfield Campus - SLC
ME Project Number: DV13044.00

Specification Sections:
23 52 00
Submittal Number: 0054-235200-0
Packaged Boiler Product Data
Review Date: 08/14/14
(Received by M-E Engineers, Inc. 08/04/14)

Subcontractor: RK Mechanical

NOTE:

Checking is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for: dimensions which shall be confirmed and correlated at the job site; Fabrication processes and techniques of construction; coordination of his work with that of all other trades and the satisfactory performance of his work.

If the use of any equipment or item in this submittal requires any deviation from the contract documents, or if there is a need to provide access or space due to dimensional constraints, the contractor shall provide a shop drawing for review showing how this item can be accommodated and shall be responsible for any deviations in related work due to its use.

Unless noted otherwise, the contractor is still responsible for performing in accordance with the contract documents.

The following items have been reviewed for conformance with the requirements of the Contract Documents:

	DISPOSITION				
Item and Review Comments Note: Items in ( ) Represent Item Tags from Equipment Schedule	**N**	**M**	**R**	**V**	**S**
Boilers					
Verify gas pressure and regulator(s) requirements, coordinate with Plumbing Contractor. Design documents based on 14" WC.		X			

M-E ENGINEERS, INC.
James Stieg, PE, LEED AP
Associate

Disposition Code:
N – No exception taken. Resubmittal not required.
M – Make corrections noted. Resubmittal not required if installation complies with notes.
R – Revise and Resubmit
V – Reviewed Only
S – Submit Specified Item

Submittal Cover Sheet

Date Submitted: July 17, 2014

Date Due Back: July 28, 2014

RK Submittal No.: 3 - 0

Specification Section: 23 5200 - Condensing Boilers

Project Name: DPS - Northfield Campus

General Contractor: GE JOHNSON CONSTRUCTION

Mechanical Contractor: RK Mechanical, Inc.
3800 Xanthia Street
Denver, CO 80238

Subcontractor/Supplier: Taft Engineering LLC
P.O. Box 3153
Englewood, CO 80155

Reviewed for general conformance with the contract requirements and with other crafts. Approved for submittal to the architects - subject to architects and engineers approval.

0054 - 23 52 00 Boilers - FA

G.E. JOHNSON CONSTRUCTION CO.

Signed by:

Date: 07/18/2014

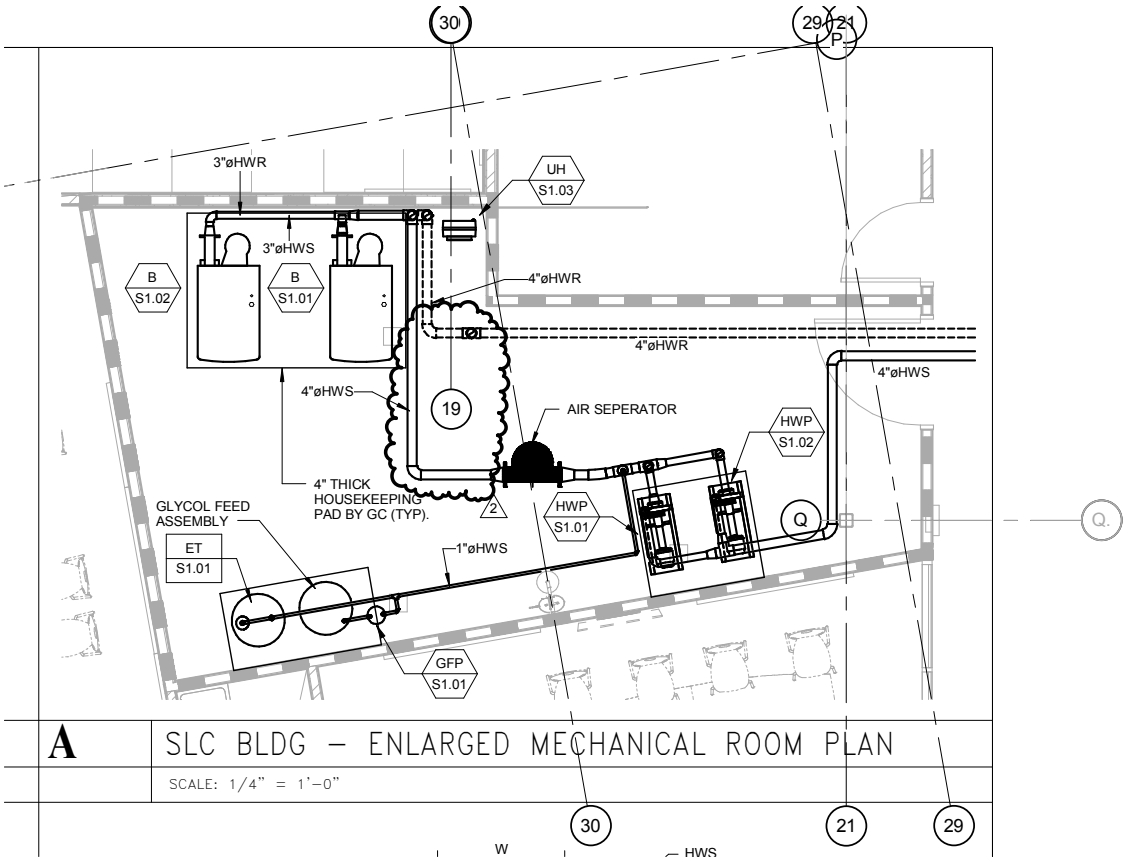
ITEM	COPIES	REV	SUBMITTAL DESCRIPTION	DRAWING	MANUFACTURER
1		0	Condensing Boilers		Aerco

Vendor to provide:
Touch screen display
Factory mounted 480v power source transformer
Flue outlet temp sensor
Spare parts as identified by the specifications.

Boiler to be compatible with operating on emergency generator power

3800 Xanthia Street
Denver, Colorado 80238
ph: 303.355.9696
fx: 303.355.8666
www.rkmi.com

SHOP DRAWING:
BOILERS WILL BE LOCATED ON HOUSEKEEPING PAD AS SHOWN ON M6.01 IN AREA C (ROOM 142) MECHANICAL.



Condensing Boilers

Vendor to provide:
Touch screen display
Factory mounted 480v power source transformer
Flue outlet temp sensor
Spare parts as identified by the specifications.

Boiler to be compatible with operating on emergency generator power

AERCO INTERNATIONAL, INC.

100 Oritani Drive, Blauvelt, NY 10913, Phone 845-580-8000

TRANSMITTAL OF SUBMITTAL DRAWINGS

Date: June 26, 2014

Project: Stapleton
Northfield HS - DPS

Purchaser: RK Mechanical
3800 Xanthia St.
Denver, CO 80238
Attn: Brian Hansen

Purchase Order #: 4091-P001
AERCO Register #: TBD
Taft Project #: 20546
# of Submittals: 1 - Electronic

The enclosed materials:

[X] **REQUIRE ENGINEER'S APPROVAL**

Your order is being held pending the receipt of your written release and one set of approved drawings. As soon as these are received at Aerco, we will release the order in accordance with the production schedule shown on the cover page of the submittal. This data should be returned to us through your Taft Engineering contact.

[ ] **ARE FOR RECORD ONLY**

Please forward required sets of drawings which are enclosed to your customer, along with letter of transmittal. Retain one for your records.

PLEASE SELECT ONE OPTION BELOW UPON RETURN OF SUBMITTALS

[ ]	Building Supply Gas Pressure is:	≤14.0" WC
[ ]	Building Supply Gas Pressure is:	>14" WC to 20" WC
[ ]	Building Supply Gas Pressure is:	>20.0" WC - 1.5psi
[X]	Other (Please Specify)	> 1.5psi - 2psi - Please Confirm

NOTE: Aerco Gas Regulators are based upon the building supply gas pressure. If no selection is chosen at time of release, then NO gas regulator will be supplied unless previously stated on the quotation that has been referenced on the customer's purchase order.

AERCO INTERNATIONAL, INC.

100 Oritani Drive, Blauvelt, NY 10913, Phone 845-580-8000

TABLE OF CONTENTS

Date:	6/26/2014	**Engineer:**	ME Engineers
Project:	Stapleton Northfield HS - DPS	**Engineer's Location:**	Denver, CO
Project Location:	Denver, CO	**Purchaser:**	RK Mechanical
Taft Project #:	20546	**Purchase Order #:**	4091-P001

DESCRIPTION	DOCUMENT
- PURCHASED EQUIPMENT	
- ACCESSORIES AND SPECIAL NOTES	
- WARRANTY (SPECIAL)	
- BENCHMARK TECHNICAL DATA SHEET	BMK SERIES
- BST TECHNICAL DATA SHEET	
- CMORE TECHNICAL DATA SHEET	
- PROTONODE COMMUNICATION GATEWAY DATA SHEET	
- BTU VS. VALVE POSTION CHART	
- WATER SIDE PRESSURE DROP CHART	
- THERMAL EFFICIENCY CHART	
- DEMINSIONAL DRAWING	AP-A-936 REV. A
- ANCHOR BOLT LOCATION	SD-A-896 REV. C
- CLEARNCE DRAWING ZERO SIDE WALL	SD-A-996 REV. A
- CMORE CONTROLS ONBOARD BST WIRING DIAGRAM	SD-A-1011 REV. A
- MOTORIZED VALVE DATA SHEET	
- GAS REGULATOR	SD-A-630 REV. B
- CONDENSATE NEUTRALIZER KIT	BKI-2000
- FLOW SWITCH DATA SHEET	
- GAS SUPPLY DESIGN GUIDE	GF-2030
- VENTING AND COMBUSTION AIR GUIDE	GF-2050
- ELECTRICAL POWER GUIDE	GF-2060

AERCO INTERNATIONAL, INC.

100 Oritani Drive, Blauvelt, NY 10913, Phone 845-580-8000

PURCHASED EQUIPMENT

Date: 6/26/2014
Project: Stapleton Northfield HS - DPS
Project Location: Denver, CO
Taft Project #: 20546
Engineer: ME Engineers
Engineer's Location: Denver, CO
Purchaser: RK Mechanical
Purchase Order #: 4091-P001

Purchased Equipment:

Model: **BMK1500**

Style: **GWBR9**
Description: **Aerco Condensing Boiler, 1500MBH, LowNOx, Natural Gas Firing**
Quantity: **2**

Including the following:

- Control Mode: Boiler Sequencing Technology
- Fault Mode Diagnostic Panel with Digital Readout
- Electrical Supply Requirements: 120V/1Ph/60HZ (16FLA)
- Gas Train is in accordance with CSD-1 and IRI
- Normally Open Fault Relay
- Adjustable Automatic Reset High Limit
- Manual Reset High Limit - 210°F Setpoint
- 20:1 Modulating Air/Fuel Valve
- Electric Probe Low Water Cut-Off
- Combination Temperature and Pressure Gauge
- Insulated Heat Exchanger
- Pressure Relive Valve, set at 75 psi (shipped loose)
- Condensate Trap (shipped loose)

AERCO INTERNATIONAL, INC.

100 Oritani Drive, Blauvelt, NY 10913, Phone 845-580-8000

ACCESSORIES AND SPECIAL NOTES

Date: 6/26/2014
Project: Stapleton Northfield HS - DPS
Project Location: Denver, CO
Taft Project #: 20546
Engineer: ME Engineers
Engineer's Location: Denver, CO
Purchaser: RK Mechanical
Purchase Order #: 4091-P001

Accessories:

QTY:	Part #:	Description:
2	58088-W75	Accessory Kit for 75psi Relief Valve
2	124259	Low Pressure Gas Regulator, 1-1/2" NPT
1	64084	Protonode Communication Gateway for BACnet
1	62010	Transformer for Gateway
2	BKI-2000	Condensate Neutralizer Kit - Up to 2000MBH
2	92084-8	3" Motorized Valve, 24V, w/ Electronic Fail Safe
2	FS251	3" Flow Switch
2		480V to 120V Tranformer
1	61040	BST Header Temperature Sensor

Shipping date is 4-6 weeks following receipt of submittal approval and written release.
Lead time is subject to change. Confirm lead-time with factory at time of release.

Note: This portfilio includes detailed data and drawings covering AERCO products to be furnished for the above project. Other equipment shown on Installation drawings is recommended for good installation practice. However, only those items listed above and within the accessories description will be furnished by Aerco.

Prices are firm 4 months from the date of the purchase order. Orders released by the customerfor shipment after the 4 month period will be billed at prices in effect at the time of shipment, orescalated at 1.5% per month, whichever is less.

AERCO INTERNATIONAL, INC.

100 Oritani Drive, Blauvelt, NY 10913, Phone 845-580-8000

Equipment Warranty Information

Date: 6/27/2014
Project Name: Stapleton Northfield HS - DPS
Project Location: Denver, CO
Taft Project #: 20546
Model #: BMK1500
Model Style: GWBR9

Serial Number(s): TBD

Engineer: ME Engineers
Engineer's Location: Wheat Ridge, CO
Purchaser: RK Mechanical
Purchase Order #: 4091-P001
Aerco SO#: TBD
Quantity: 2
Date of Shipment: TBD

Warranty Description - Job Specific

Pressure Vessel/Heat Exchanger: **2 Years from Date of Shipment**
Boiler/Water Heater Controls: **2 Years from Date of Shipment**
Parts/Other Components: **2 Years from Date of Shipment**

**** See Attached Document for Standard Warranty Information ****

Product Support Contact Information

Taft Engineering Inc.
Cory Hesterwerth
Product Support Manager
9800 E. Easter Ave.
Suite 130
Centennial, CO 80112
(P) 303-753-4584
(T) 720-941-1199

BENCHMARK LIMITED WARRANTY

BENCHMARK 750 - 6000 GAS-FIRED BOILER

PRESSURE VESSEL/HEAT EXCHANGER: 10 YEAR NON-PRORATED FROM SHIPMENT The pressure vessel/heat exchanger shall carry a 10 year non-prorated, limited warranty from date of shipment against any condensate corrosion, thermal stress failure, mechanical defects or workmanship. Operation of the boiler using contaminated air will void the warranty. The pressure vessel/heat exchanger shall not be warranted from failure due to scaling, liming, corrosion, or erosion due to water or installation conditions. AERCO will repair, rebuild or exchange, at its option the pressure vessel/heat exchanger.

"C-MORE" CONTROL PANEL: 2 YEARS FROM SHIPMENT

AERCO labeled control panels are conditionally warranted against failure for (2) two years from shipment.

OTHER COMPONENTS: 18 MONTHS FROM SHIPMENT

All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 18 months from shipment.

The warranty as set forth on the back page of the Operations & Maintenance Manual is in lieu of and not in addition to any other express or implied warranties in any documents, or under any law. No salesman or other representative of **AERCO** has any authority to expand warranties beyond the face of the said warranty and purchaser shall not rely on any oral statement except as stated in the said warranty. An Officer of AERCO must do any modifications to this warranty in writing. **AERCO MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTIES. AERCO** disclaims all responsibility for any special, incidental or consequential damages. Any claim relating to the product must be filed with AERCO not later than 14 days after the event-giving rise to such claim. Any claims relating to this product shall be limited to the sale price of the product at the time of sale. The sale of the product is specifically conditioned upon acceptance of these terms.

CONDITIONS OF WARRANTY:

Should an **AERCO** gas-fired (natural gas, propane, and natural gas/propane dual fuel only) boiler fail for any of the above reasons within the specified time period from the date of original shipment(s), **AERCO** shall at its option modify, repair or exchange the defective item. **AERCO** shall have the option of having the item returned, FOB its factory, or to make field replacements at the point of installation. **In no event shall AERCO be held liable for replacement labor charges** or for freight or handling charges.

AERCO shall accept no responsibility if such item has been improperly installed, operated, or maintained – as defined in the applicable **AERCO** O&M manual, or if the buyer has permitted any unauthorized modification, adjustment, and/or repairs to the item. The use of replacement parts not manufactured or sold by **AERCO** will void any warranty, express or limited.

(Continued)

(Continued)

AERCO shall accept no responsibility if such item has been damaged due to contaminated combustion air containing but not limited to sheetrock particles, plaster board particles, dirt, dust, lint, and corrosive chemicals such as chlorine gas, halogenated hydrocarbons, and Freon.

In order to process a warranty claim a formal purchase order number is required prior to shipment of any warranty item. In addition, the returned item must include a Returned Goods Authorization (RGA) label, attached to the shipping carton, which identifies the item's return address, register number and factory authorized RGA number.

Warranty coverage for all components and equipment mentioned in said warranty are not valid unless the water heater is started up by a factory certified SST (Service, Start-Up and Troubleshooting) Technician and an **AERCO** start-up sheet is completed.

This warranty coverage is only applicable within the United States, Canada and Mexico. All other geographical areas carry a standard warranty of 18 months from date of shipment or 12 months from startup, whichever comes first.

Rev. 11/22/13

BMK SERIES
TECHNICAL DATA SHEET

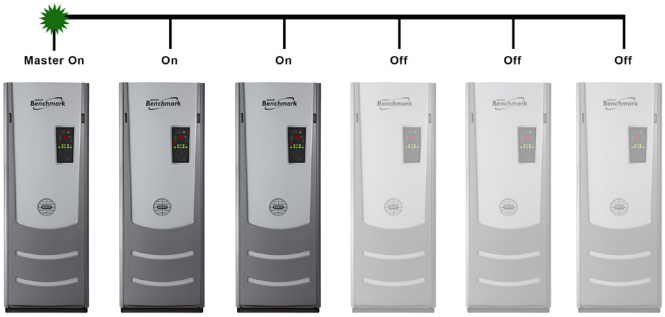
Benchmark 750 - 6000
Condensing Hydronic Boilers

The AERCO Benchmark (BMK) Water Boiler is designed for condensing application in any closed loop hydronic system. It delivers unmatched burner modulation to match energy input directly to fluctuating system loads to yield the highest possible seasonal efficiencies. And no other product packs as much capacity into such a small footprint.

To minimize emissions, the BMK Series is fitted with a low NOx burner whose emissions will meet the most stringent NOx and CO requirements. The fully modulating burner also maintains AERCO standards for energy efficiency, longevity, reliability and construction quality.

The BMK Series comes standard with AERCO's Patent Pending, Oxygen Level (O_2) monitoring system. This monitoring system, designed to display the O_2 level directly on the unit in real time, can also be remotely monitored via Modbus giving the customer the ability to measure the emissions level and fuel economy of the boiler without traditional combustion calibration devices.

The BMK boilers can be used as an individual unit or in modular arrangements and offers selectable modes of operation. In addition to controlling the boiler according to a constant set point, indoor/outdoor reset schedule or 4-20mA signal, one or more units can be integrated via Modbus communications protocol. For boiler plants ranging from 2-8 boilers, AERCO'S built-in Boiler Management Sequencer* can be utilized. For heating plants greater than 8 boilers, AERCO's ACS (AERCO Control System) provides the right solution. Likewise, Benchmark systems can be easily integrated with a facility-wide Energy Management or Building Automation System.



*AERCO's on-board BMS sequencer available December 2013

FEATURES:

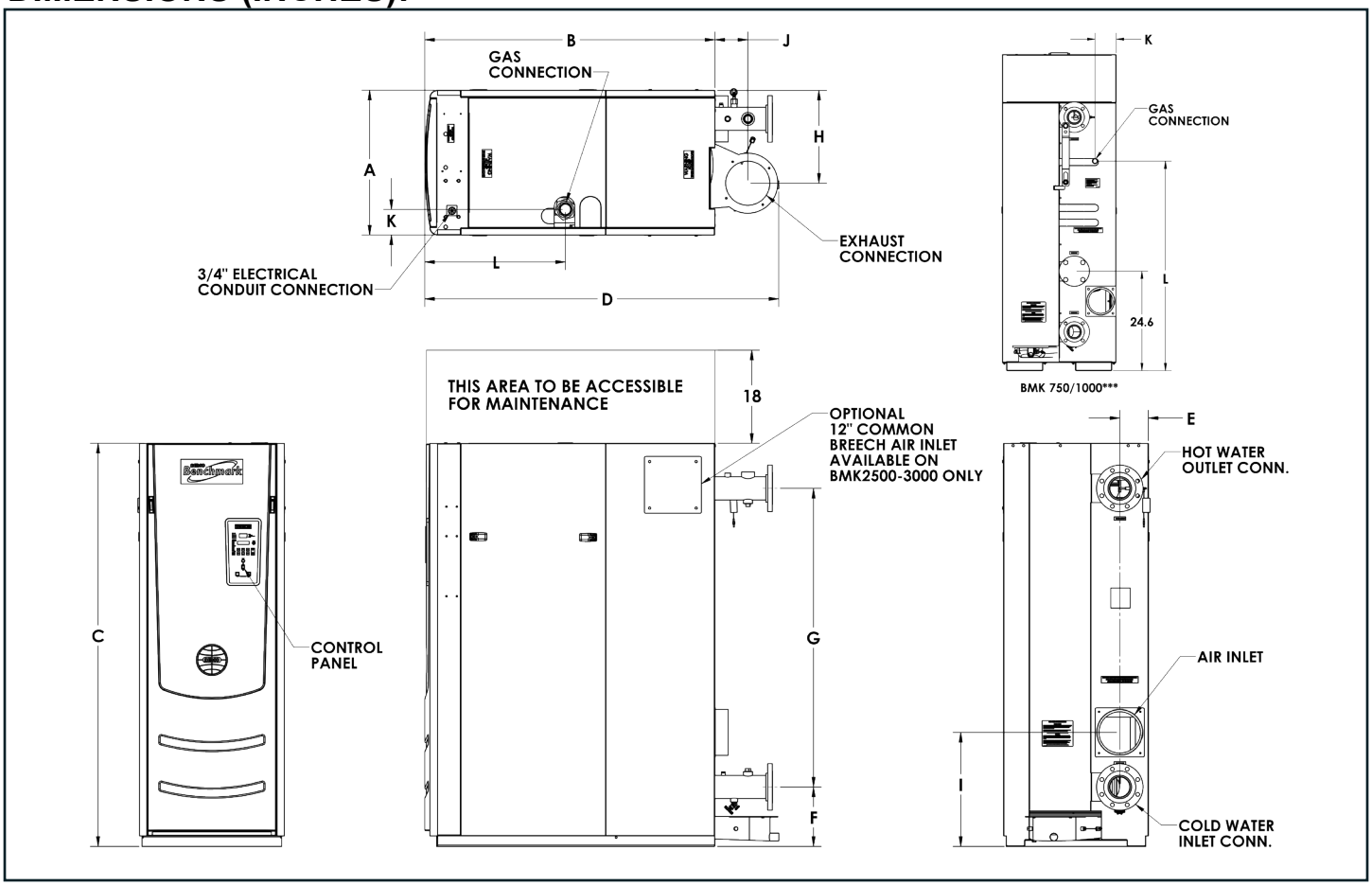
- Natural Gas, Propane, or Dual Fuel (model dependant)
- 20:1 Turndown Ratio (5%) depending on capacity
- Oxygen Level (O_2) Monitoring Standard
- Stainless Steel Fire Tube heat exchanger
- Capable of variable primary flow Installations
- NOx Emissions capable of 9PPM or less @ all firing rates *depending on capacity
- Compact Footprint
- Precise Temperature Control
- On Board Boiler Management Sequencer (BMS)
- Ducted Combustion Air Capable
- Easy Open Access for Service
- Acceptable vent materials AL29-4C, Polypropylene, PVC, cPVC (model dependant)
- Reliable Quiet Operation
- Controls Options
  - Constant Setpoint
  - Indoor/ Outdoor Reset
  - Remote Setpoint
  - 4-20mA signal or ModBus

RATINGS:

Model Number	Min Input MBH	Max Input MBH	Max Output[a] MBH	Efficiency Range	AHRI Efficiency 80º to 180ºF
BMK 750	50	750	653-720	87%-98%	95.50%
BMK 1000	50	1000	870-960	87%-98%	96.80%
BMK 1500	75	1500	1305-1425	87%-99%	95% (pending)
BMK 2000	100	2000	1740-1900	87%-98%	95% (pending)
BMK 2500	167	2500	2175-2360	87%-98%	93.50%
BMK 3000	200	3000	2610-2880	87%-98%	93.50%
BMK 6000**	400	6000	5220-5670	87%-98%	94.50%

[a]Max output dependent upon application - See efficiency curves
**See separate BMK6000 Technical Data Sheet for additional BMK6000 details

DIMENSIONS (INCHES):



Model	(Width) A	(Depth) B	(Height) C	D	E	F	G	H	I	J	K	L
BMK 750	28”	25”	78”	34”	10”	10”	53”	21”	17”	4”	5”	51.8”
BMK 1000	28”	25”	78”	34”	10”	10”	53”	21”	17”	4”	5”	51.8”
BMK 1500	28”	43.6”	78”	58.4”	7”	11.5”	57.8”	18”	22”	8.9”	4.7”	19.5”
BMK 2000	28”	43.6”	78”	58.4”	7”	11.5”	57.8”	18”	22”	8.9”	4.7”	19.5”
BMK 2500	28”	56”	78”	68.4”	5.4”	11.5”	57.8”	18”	22”	6.4”	3.6”	26”
BMK 3000	28”	56”	78”	68.4”	5.4”	11.5”	57.8”	18”	22”	6.4”	3.6”	26”
BMK 6000**	34”	89.3”	79.4”	108.3”	6.2”	42.1”	N/A	15.6”	N/A	10”	28.7”	23.7”

**See separate BMK6000 Technical Data Sheet for additional BMK6000 dimension details
***BMK750/1000 Feature Dual Inlet Connections

SPECIFICATIONS:

	BMK750	BMK1000	BMK1500	BMK2000	BMK2500	BMK3000	BMK 6000**
Boiler Category	ASME Sect.IV	ASME Sect.IV	ASME Sect.IV	ASME Sect.IV	ASME Sect.IV	ASME Sect.IV	ASME Sect.IV
Gas Connections (NPT)	1"	1"	1.5"	2"	1.5"	2"	2"
Max. Gas Pressure	14"	14"	14"	14"	14"	14"	2psi
Min. Gas Pressure	4"	4"	4"	4"	4"	4"	14"
Max. Allowed Working Pressure	160 PSIG	160 PSIG	160 PSIG	160 PSIG	160 PSIG	160 PSIG	80 PSIG/150 PSIG Optional
Electrical Req. 120V/1PH/60Hz [1]	13 FLA	13 FLA	16 FLA	16 FLA	N/A	N/A	N/A
Electrical Req. 208V/3PH/60Hz [1]	N/A	N/A	N/A	N/A	10 FLA	10 FLA	19 FLA
Electrical Req. 460V/3PH/60Hz [1]	N/A	N/A	N/A	N/A	5 FLA	5 FLA	12 FLA
Water Connections (Flanged)	3"	3"	4"	4"	4"	4"	6"
Min. Water Flow (GPM)	25	25	25	25	35	35	75
Max. Water Flow (GPM)	175	175	250	350	350	350	600
Water Volume Gallons	16.25	14.25	34	28	58	55	110
Water Pressure Drop	3.0 PSIG @ 100 GPM	3.0 PSIG @ 100 GPM	3.0 PSIG @ 170 GPM	3.0 PSIG @ 170 GPM	3.0 PSIG @ 218 GPM	3.0 PSIG @ 261 GPM	4.0 PSIG @ 570 GPM
Turndown	15:1 (7%)	20:1 (5%)	20:1 (5%)	20:1 (5%)	15:1 (7%)	15:1 (7%)	15:1 (7%)
Vent/Air Intake Connections	6 Inch	6 Inch	6 Inch	8 Inch	8 Inch	8 Inch	14 Inch
Vent Materials	AL29-4C Polypro, CPVC, PVC	AL29-4C Polypro, CPVC, PVC	AL29-4C Polypro	AL29-4C Polypro	AL29-4 Polypro	AL29-4C Polypro	AL29-4C
Type of Gas	Natural Gas, Propane	Natural Gas, Propane	Natural Gas, Propane, Dual Fuel	Natural Gas, Propane, Dual Fuel	Natural Gas, Propane, Dual Fuel	Natural Gas, Propane, Dual Fuel	Natural Gas, Propane, Dual Fuel
Temperature Control Range	50ºF to 190ºF						
Ambient Temperature Range	0ºF to 130ºF						
Standard Listings & Approvals	UL, CUL, CSD-1, ASME, AHRI						
Gas Train Operations	FM Compliant or Factory Installed DBB (IRI) (BMK750-BMK3000 Only) FM Compliant (BMK 6000)						
Weight (dry) lbs.	669	700	1406	1500	2,000	2,170	3,000
Weight (wet) lbs.	802	817	1654	1760	2,332	2,580	3,920
Shipping Weight lbs.	862	900	1606	1700	2,200	2,370	3,800

**See separate BMK6000 Technical Data Sheet for additional BMK6000 details

[1] See Benchmark Electrical Power Guide GF-2060 for Service Disconnect Switch amperage requirements.

NOTES:

Represented By:

WATER HEATERS • BOILERS • PARTS & ACCESSORIES
AERCO INTERNATIONAL, INC.
100 ORITANI DR. • BLAUVELT, NY 10913
(845) 580-8000 • FAX (845) 580-8090
www.aerco.com

Specifications subject to change without prior notice. Consult website or contact AERCO.
BMK SERIES 08/2013 NY

BST
TECHNICAL DATA SHEET

C-MORE CONTROLLER WITH BOILER SEQUENCING TECHNOLOGY (BST)

LOAD SHARING STRATEGY MAXIMIZES ENERGY EFFICIENCY

It requires less energy for a group of modulating boilers, each firing at “part load,” to heat a building, than for a single boiler operating at “full fire” to carry the entire workload. To meet building demand, the BST will employ as many boilers as available, each operating at its most efficient firing rate. Importantly, because the BST reacts in real-time to, up to 8 boilers, changes in the number of boilers available, users can take a unit offline for maintenance at any time or bring on back-up boilers for extremely cold conditions without changes to the BST. And as individual boilers are added or deleted, the energy delivered is automatically adjusted to prevent fluctuations in the header temperature of the plant.

Typical Staging Example Demonstrates “Part Load” Efficiency

The first boiler unit comes online and will gradually increase its air-fuel valve position to meet demand. When it reaches 50% – a second unit is called into service.

The two boilers will split the load – each firing at 30% air-fuel valve position to meet demand. If additional heat is required, a third unit is called into service.

Three boilers, each firing at 30% air-fuel valve position, satisfies the demand more efficiently than either two units at 50% or one unit at 100%. This same principle applies to much larger plants.

FEATURES:

- Increase System Turndown to Maximize Operating Efficiency
- Control Up to 8 Boilers via Modbus Interface
- Automatic Load Matching Precisely Meets Demand Changes
- “Bumpless” Energy Transfer
- Multiple Configuration Options
- User-Friendly Software Makes Programming Easy
- Full System Information VFD Display on Master Unit
- Controls external 24V AC/DC motorized isolation valve
- Easy Integration to BAS or EMS via Modbus Open Protocol
- Single Point BAS or EMS Data Gathering for up to 20 BAS System Operating Parameters and 18 Operating Parameters of Each Boiler
- Available Standard on all AERCO Benchmark Boilers. No Additional panel necessary.
- Can incorporate different unit capacities for optimized efficiency.
- Utilizes a Header Senor directly connected to the BST Master Unit, or an optional Modbus Header Sensor.

STATE-OF-THE-ART CONTROL SYSTEM SUPPORTS EFFICIENT BOILER PLANT OPERATION!

The C-MORE AERCO with Boiler Sequencing is a flexible controller designed to maximize energy savings in modular boiler plants. The BST can stage and coordinate the operations of up to 8 boilers and is uniquely designed to maximize uptime reliability and the operating efficiency of condensing equipment capable of unmatched modulation. For boiler plants greater than 8 boilers, the AERCO Control System (ACS) panel is required.

Able to regulate overall plant output with precise accuracy, a boiler plant with ±4°F header temperature variation is assured under normal load conditions. It offers sequential or parallel operation flexibility, and user programmable modes of operation that can be changed in the field. The C-MORE automatically rotates the lead unit to help equalize boiler runtime or number of cycles.

FULLY COMPATIBLE WITH BAS OR EMS SYSTEMS VIA MODBUS OPEN PROTOCOL

For facilities that have taken a building-wide approach to energy efficiency, the C-MORE supports easy integration with Building Automation Software (BAS) or Energy Management Software (EMS) programs via Modbus protocol and RS-485 interface. A standards-based open protocol used throughout the buildings controls market, Modbus integration will enable facility managers to monitor all operations from any building control platform. BAS or EMS can poll 20 System Operating Parameters, and 18 unit Operating Parameters per Boiler through a single connection, including: (for greater detail consult AERCO Modbus Communications Manual GF-114).

BST System Parameters

- Cmore BST mode
- BST setpoint
- BST setback setpoint
- BST setback start
- BST setback end
- BST auto master
- BST Unit outlet temp
- BST num units enabled
- BST units faulted
- Master Unit Address
- BST header temp
- BST outdoor temp
- BST fire rate output
- BST Unit Ignited
- BST Active Setpoint
- Next turn on fire rate
- BST sp high limit
- BST sp low limit
- BST temp high limit
- BST setpoint mode

Boiler Parameters

- Comm addr
- Unit Status
- Fault status
- Outlet temp
- Ffwd temp
- Inlet temp
- Exhaust temp
- Air temp
- Flame strength
- Fire rate in
- Fire rate out
- Unit type
- Unit size
- Boiler Isolation Valve State
- Network remote setpoint
- Run cycles
- Run hours
- O2 Level

Configuration Options	Typical Applications
Indoor/Outdoor Reset A change in the outside air condition results in a Process Application proportionate change in header temperature – a function of the adjustable reset ratio (0.3 – 3.0).	**Indoor/Outdoor Reset Hydronic Heating** **Process Application**
Constant Setpoint Delivers fixed supply water temperature at set points of 50°F-220°F (dependent upon boiler maximum temperature limit).	**Water Source Heat Pump** **Domestic Water Generation** **Supplemental Heat Recovery Equipment** **Swimming Pool Heating**
4-20mA Signal Header temperature responds linearly to an external 4-20mA control signal.	**Computer Controlled Building Management** **Industrial Process** **Greenhouse Application**
Network Communications Enables EMS or BAS system to drive boiler plant setting for header set point temperature via Modbus connection to BST. Also provides communication link between the boiler and the BST to allow direct communication. This enables the EMS/BAS to query and capture faults of BST and 20 BST System operating parameters as well as 18 operating parameters of each individual boiler.	**Computer Controlled Building Management** **EMS Data Logging & Trend Analysis**

NOTE: Supply Header Temperature Sensor Is Sold Separately (See OnBoard BST O&M)

ROBUST FEATURES SIMPLIFY CONTROL

- **Application Flexibility** – Different configuration options meet the needs of any closed loop system and can be changed in the field.
- **Time Delay Between Boiler Start** – An adjustable time delay between boiler starts allows for a smooth energy input without spikes in electrical, gas or venting conditions.
- **Automatic Allowance for Maintenance** – By continuously monitoring the number of boilers available for operation, the system will automatically operate the next boiler needed to meet demand if a unit malfunctions or is taken off-line for maintenance.
- **Adjustable Off Set** – The BST includes a 7-day programmable clock to support night setback and/or daily setback periods. The BST will shift from the original set point to a higher or lower temperature.
- **Two Interlock Circuits** – Monitor pumps, combustion air dampers, or other equipment using two interlock circuits that must be completed before plant operations begin.
- **Power Off Memory** – By using non-volatile memory, programs are retained through a shut down of more than two years. No batteries required.
- **Simple Installation** – The C-MORE control system operates on boiler unit's standard power supply.Twisted pair, shielded wire connections between the Master boiler unit and slave individual boilers is required to support communications. An RS-485 interface is required to link an EMS. RS-485 communications wiring supports a distance of up to 4,000 feet between BAS and boilers.
- **Flexible & Expandable** – The BST can support up to 8 AERCO boilers – which can be fully integrated with any EMS or BAS software via the Modbus protocol. AERCO also offers Gateway product for LON, BACnet (additional gateway product required) and Johnson Controls N_2.
- **Building Reference Temperature Inputs** – Boilers can be clamped at minimum and maximum temperatures, and the building reference temperature adjusted to drive plant header temperature. This allows a wide range of boiler responses to outside air changes for maximum comfort.
- **Accuracy** – The BST uses PID (Proportional & Integral + Derivative) and Dynamic Up/Dynamic Down Modulation control algorithm to provide a dynamic response to all changes in plant operation. Header temperatures, as well as percentage boiler input, are precisely controlled with virtually no overshoot or short cycling of equipment. A header temperature of ±4°F is assured during continual plant operation.
- **"Bumpless" Energy Transfer** – When staging boilers sequentially, the BST can bring additional units online at an adjustable percentage of input selected by the user.
- **Lead and Lag Boiler Designation** – The BST will select the Lead and Lag boilers by either Unit Size or Run Hours depending on user setting. The Lead and Lag boilers can also be manually selected by the user.
- **Lead Boiler Time Rotation** – Rotates the operating lead boiler at specified time and helps equalize runtime.
- **Anti-Cycling Features** – These features prolong the system's stay at specific state (firing/off) - reducing the number of cycles while maintaining accurate temperature control.
  - Shutoff Delay Temp
  - Deadband high
  - One Boiler Mode
  - Demand offset
  - Deadband low
- **One Boiler Mode** – is an INNOVATIVE and EXCLUSIVE feature in the AERCO BST control that detects a "low-flow" condition in a multi-boiler system. When the AERCO BST determines that a low-flow condition exists, it will slowly shut down one boiler at a time in an attempt to raise the Fire Rate of the remaining boilers. If the low-flow condition persists and only a single boiler remains ignited, the AERCO BST will use the "Outlet Temperature Sensor" of the remaining ignited boiler to control the temperature. The Outlet Temperature Sensor is mounted in the individual boiler and drastically increases the response time to precisely control temperature. The distant header sensor is ignored in this mode of operation.

- **Setback Setpoint Gradual Decrease** – Whenever boilers are running at a high rate and the Setback-Setpoint feature is activated, the sudden decrease in setpoint will cause the PID to drastically cut back on fire rate. This sudden decrease in fire rate will often cause the boilers to drop below their Stop Levels causing them to turn off, thereby causing excessive cycling and loss of heating capacity while the boilers can re-ignite. The **Setback-Setpoint gradual decrease** feature will decrease the setpoint, lowered by the activation of the Setback-Setpoint feature, at a slow rate thereby allowing the PID to recover and prevent any boilers from shutting down if not required to do so.

- **Warm-Up and Low-Fire-Delay Fire Rate Hold** – When an extra boiler is ignited to meet demand, the fire rate of all ignited boilers will be held at their present level until the newly ignited boiler has completed Warm-up and Low Fire Delay. When the newly ignited boiler has completed Warm-up and Low Fire Delay, all boiler fire rates will decrease to approx 30% Fire Rate. All boiler fire rates will then rise together to the required fire rate to meet demand.

- **Next Turn On Valve Position** – When all ignited boilers reach or exceed the **BST Next on VP** value, another boiler will be ignited to share the load (if one is available). The default value is 50%.This feature is also useful if a user wishes to always have as few boilers on at any one time. Setting the **BST Next on VP** value to a high number (Example 100%) will only ignite a new boiler if all currently ignited boilers reach their total BTU capacity (100%).

- **Warm-Up and Low-Fire-Delay PID Hold** – Whenever any boiler is in either Warm-up or Low Fire Delay, the Integral portion of the BST PID will be frozen in order to prevent the PID from winding up too high causing the temperature to overshoot causing an over-temp condition.

- **Setpoint Approach Rate control** – To avoid header temperature overshoots, whenever the header temperature nears the setpoint temperature at a rate too quickly to prevent a temperature overshoot, the BST fire rate will temporarily decrease in order to lower the temperature rise momentum. This feature will help avoid temperature overshoots due to variable flow as well as other conditions.

SPECIFICATIONS:

Standard Listings & Approvals ....UL, CUL

NOTES:

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(845) 580-8000 • FAX (845) 580-8090
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Specifications subject to change without prior notice.
Consult website or contact AERCO.
BST 2/2014 NY

CMR
TECHNICAL DATA SHEET

AERCO C-More™ Control System

AERCO C-More Controller for Benchmark Boilers and Innovation Water Heaters

Advanced Technology for Easy and Reliable Control of AERCO Gas-Fired Boilers and Water Heaters.

The AERCO C-More Control System offers customers more than just an easy-to-use, highly reliable control system for boiler and water heater management. The system incorporates the latest electronic technology to see and do more than was previously possible. It reports on individual system components such as unit status, firing rate and temperature control settings. It provides step-by-step diagnostic menus using clear and simple language and automatically captures performance history and operating trends.

Beyond these immediate benefits, the ruggedly built system has been designed using flash-upgradeable software components and open interoperability standards to support building automation and energy management software systems. Integrated Boiler and Water Heater Sequencing Technology is offered standard for optimal system efficiency and reliability.

It is included as a standard component on all AERCO Benchmark Boilers and Innovation Water Heaters. Older installations of the Benchmark boilers and discontinued KC1000 boilers and water heaters can be easily retrofitted with the AERCO C-More control system.

FEATURES:

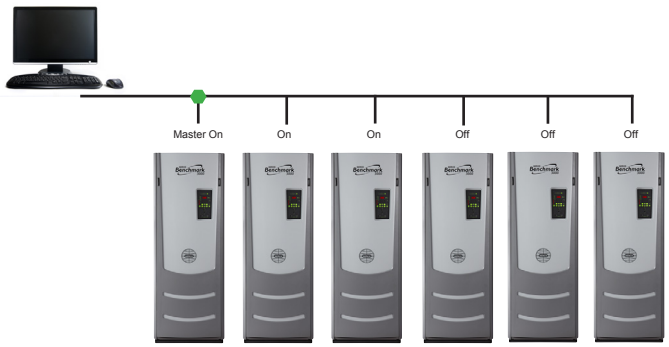
- Supports BAS and EMS Integration via ModBus Open Protocol
- Integrated Boiler Sequencing Technology (BST) on Benchmark Units
- Water Heater Management (WHM) on Innovation Units
- Optional Gateway for BACnet, Lonworks and N2 Communication Also Available
- Common Platform on all Benchmark and Innovation Units
- Log Reports and Fault History
- Rugged Hardware Design
- Simple and Clear Display Messages
- Step-by-Step Diagnostic Menus and System Status Reports
- Remote Monitoring Capability
- Precise Temperature Control
- UL Recognized

Future-Proof Software in a Hardware Enclosure that is Built to Last

The most important feature of any product manufactured in today's "information age" is its ability to network with related equipment. And not just the equipment and systems that are available today – but those that are still on the horizon. This indisputable fact was a guiding principle in the design of the AERCO C-More Control System. It pairs software flexibility with hardware durability to ensure that your AERCO equipment will be as current tomorrow as it is today.

Integrated Sequencing Technology

The C-More's integrated Boiler Sequencing Technology (BST) for Benchmark boilers & Water Heater Management (WHM) for Innovation Water Heaters is designed to maximize energy savings and uptime reliability in modular unit plants. The BST/WHM system can stage and coordinate operations for up to 8 units, utilizing AERCO's condensing equipment's unmatched modulation for utmost plant efficiency. The system offers sequential and parallel operation flexibility, and user programmable operation modes that can be easily adjusted. Furthermore, the system automatically rotates the lead unit to help equalize runtime or number of cycles.



Extensive Log Reports

The system continuously monitors and automatically captures data associated with operational events, faults and sensor readings which can be viewed in real-time via the Modbus RS485 RTU interface or downloaded for historical analysis through the RS-232 interface. Events such as power-up, ignition, and turn-off are time stamped and sensor value readings can be logged at flexible intervals established by the user. The system also maintains a log of the date, time and details of the last ten system faults to help end-users recognize boiler shutdown patterns.

Open Platform Integrates with Energy Management Systems

The C-More controller is fully compatible with building-wide energy management systems and building automation software via ModBus open protocol. An optional Aerco Communications Gateway, to support integration with BACnet, Lonworks and N2 systems, is also available.

Flash-Upgradeable Software

Once an AERCO C-More control module is in place, all new versions of the system's operating software can be uploaded electronically (or "flashed in"). The ability to upgrade the controller – without replacing hardware, circuit cards or boiler equipment – makes it faster, easier and less expensive to take advantage of new features and management controls that become available in the future.

One Controller Fits All

AERCO C-More internal components are identical for Benchmark and Innovation equipment. Whole units or components can be swapped between any of AERCO's gas-fired boilers and water heaters as needed.

Easy Retrofits

An affordable retrofit kit is available to equip any older existing AERCO gas-fired boiler or water heater installation with a state-of-the-art AERCO C-More control system. See document GF-2200 for Retrofit Kit / Part Number Guidelines to determine the kit needed for your AERCO equipment.

Simple & Clear Display Messages are a Breeze for Maintenance Personnel

Forty-two distinct messages convey system status throughout the full start-up sequence and pinpoint the exact nature of any fault or operating problem. The easy-to-read display panel uses clear, simple language — rather than obscure programming codes – to ensure that day-to-day operations and annual maintenance goes smoothly for onsite maintenance staff and professional service contractors.

Start Sequence Messages

DISABLED
3:05PM 9/24/12

STANDBY
3:06PM 9/24/12

DEMAND DELAY
30 SEC

WAIT

PURGING
30 SEC

IGNITION TRIAL
4 SEC

WARMUP
120 SEC

FLAME PROVEN
3:08PM 9/24/12

Fault Message Examples

LOW WATER
LEVEL

AIRFLOW FAULT
DURING PURGE

LOSS OF POWER
3:09PM 9/24/12

DIRECT DRIVE
SIGNAL FAULT

REMOTE SETPT
SIGNAL FAULT

OUTDOOR TEMP
SENSOR FAULT

LINE VOLTAGE OUT
OUT OF PHASE

NETWORK COMM FAULT

Step-by-Step Menus Check and Report Status of Each Component

The system has also been designed with step-by-step diagnostic menus to help personnel troubleshoot efficiently and quickly pinpoint problems. Users can test all system components as well as test keypad function, relay settings, switch positions, air/fuel valve calibration and sensor readings.

Remote Upgrade, Monitoring and Troubleshooting Capabilities

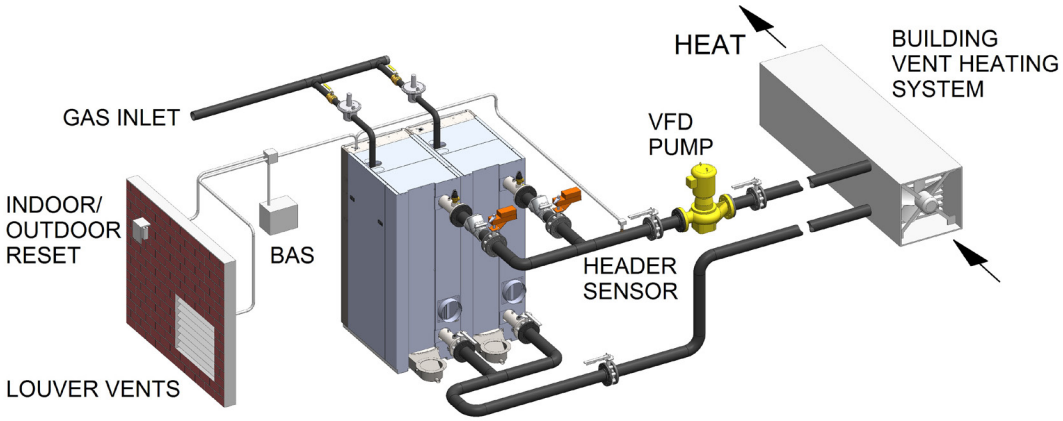
Opening the control module is unnecessary for initial system set-up, calibration, troubleshooting or during normal operations. The AERCO C-More controller links easily to a laptop via RS-232 connections so staff can monitor and troubleshoot issues remotely. AERCO also offers an optional service, On-AER Remote Monitoring, which monitors boiler plant operation, logs equipment heartbeat data and immediately notifies service representatives of any faults. The historical heartbeat data makes troubleshooting and resolving faults much easier, saving on repair time costs and offering peace of mind.

Precise Temperature Control

The superior performance of AERCO equipment is due, in part, to tremendous condensing capabilities and unique firing technology. Put simply, AERCO extracts and transfers as much heat as possible from a highly efficient combustion process. Unparalleled, fully modulating, non-stepped burner turndown precisely matches heat input to load requirements. A state-of-the-art PID control system was employed to fully exploit the potential of such robust boiler mechanics. In short, it utilizes a Proportional + Integral + Derivative control algorithm to dynamically respond to changes throughout the heating plant operation. System temperatures, as well as a percentage of module input can be controlled with virtually no overshoot, droop or short cycling of equipment. A header temperature of +/– 4°F is assured during continual plant operation.

Integrated Approach to Overall Heating Plant Infrastructure

Such precise temperature control would not be possible without a highly integrated approach to the overall heating plant infrastructure. The AERCO C-More control supports equipment and information systems which extend beyond the limits of conventional boiler controls. These features will help you maximize the value of a sophisticated energy management system, or can assist with basic heating plant management in the absence of smart building systems.



Interoperability with Energy Management Systems (EMS) is achieved via the controller's RS485 port. Customers who are not equipped to take advantage of these network technologies can monitor trends in set point, outlet temperature or firing rates using conventional 4-20 mA signals.

A **PID Temperature Control Override** function prevents unnecessary shutdowns caused by external energy management controls. The feature gradually lowers the firing rate to safely operate the boiler until conditions return to normal. This prevents on/off cycling to save energy and reduce equipment wear and tear.

To help users start the heating plant as temperatures drop – or begin to promote client comfort and energy savings as temperatures warm – System Start Temp and Indoor/ Outdoor Reset controls can be used to enable or disable the boiler based on outside air temperature.

Similarly, **Fail Safe Mode** lets users choose to shut down the system or switch to constant set point operation if external signal input is ever lost. By choosing to revert to a constant set point, users can ensure that basic heat and hot water is available to avoid unnecessary building closures and prevent pipe freezes in the event of an EMS problem.

All AERCO equipment supports **Variable Flow Designs** and **extremely low Flow Conditions** without supplemental pumping requirements. While streamlining plant design is an effective way to reduce project and overall maintenance costs, AERCO C-More features are robust enough to support the most complex heating plant infrastructures. **Remote and Delayed Interlocks**, a **Pump Delay Timer** and/or **Aux Start Delay** can postpone the boiler's start-up sequence until a necessary external device is activated. Prior to operation, it can open a valve, boiler pump, gas booster, or louver as shown.

Represented By:

Specifications subject to change without prior notice.
Consult website or contact AERCO.
CMR 03/2014 NY

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AERCO/PROTONODE GATEWAYS

AERCO offers a multi-protocol, communications gateway to support integration with customers' building control and energy management systems. The plug-n-play package supports integration with BACnet/IP, BACnet MS/TP, LonWorks, and Johnson Controls Metasys N2 systems. AERCO's Communications Gateway is available for all AERCO boilers, *water heaters and electronically controlled indirect systems. The gateway may be installed using the mounting tabs or with the included DIN mount adapter directly into the site's communications control panel. Configurations for all AERCO devices are preloaded on both gateways so the installer simply selects the protocol and configuration via the DIP switches. BACnet gateways are BTL Marked and the LonWorks gateway is LonMark compliant simplifying the commissioning process. Both gateways are programmed to communicate up to:

- Twelve (12) C-More controlled boilers or water heaters
- Four (4) AERCO Modulex boilers
- Six (6) SmartPlates or electronically controlled indirect water heaters
- Two (2) BMS II, one dedicated to control the C-More and another to control the Modulex systems

A list of standard control points for each category of equipment includes set point, fire rate, outlet temperature, unit status, run cycles and run hours.

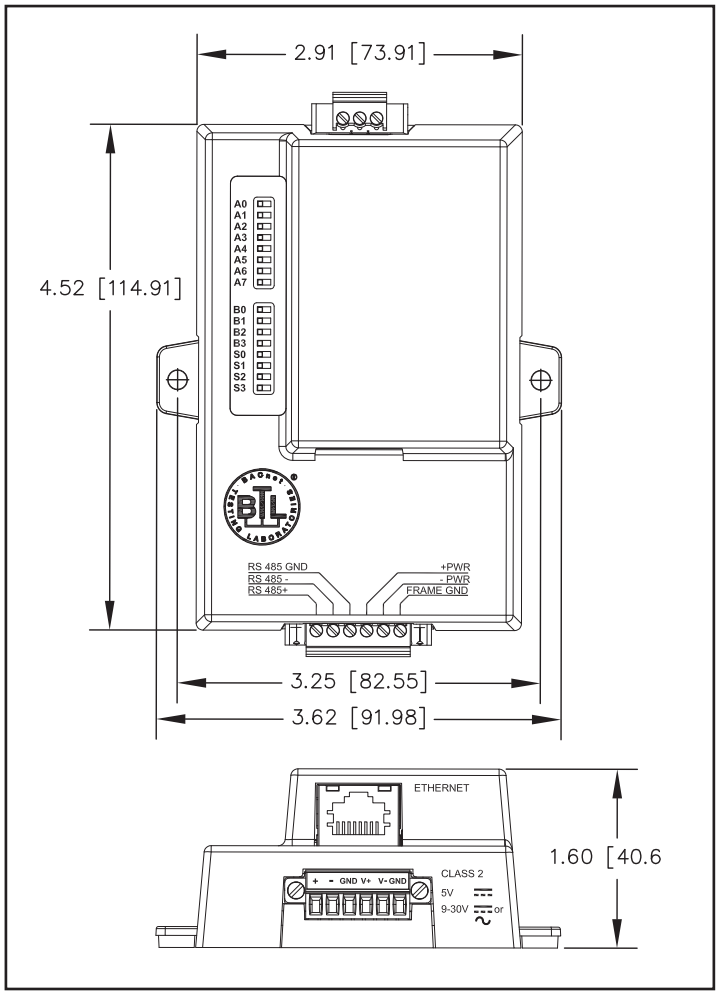
*Helitherm, U-Tube style, and SmartPlate water heaters must be equipped with the company's Electronic Control System.

FEATURES:

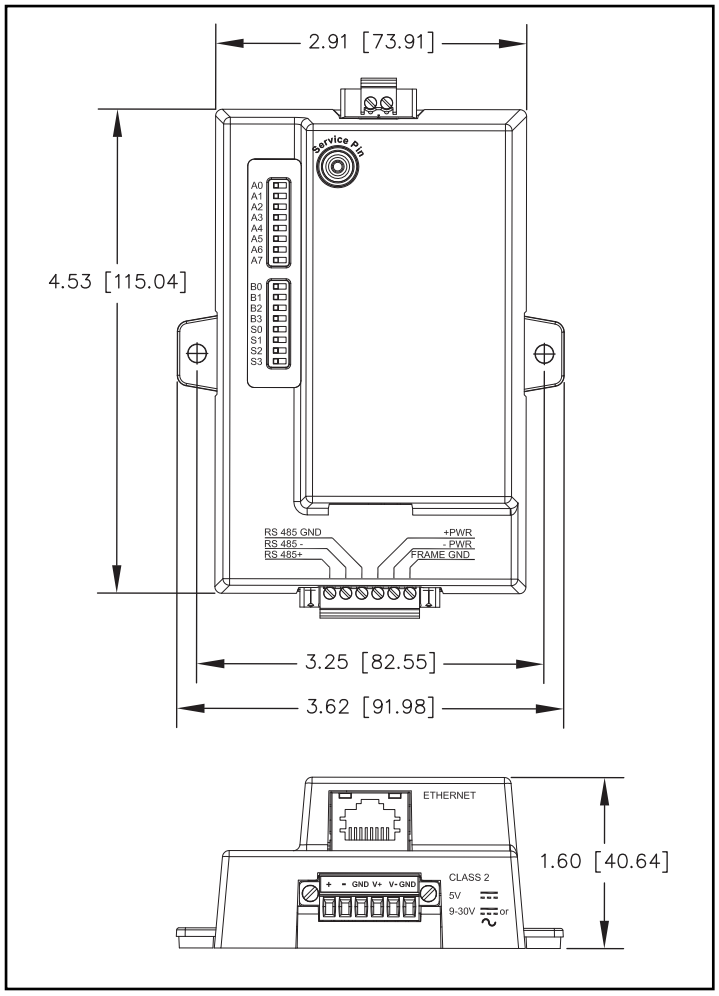
- Built-in translation for BACnet/IP, BACnet MS/TP, LonWorks, Metasys N2 and Modbus TCP Protocols
- Select protocol and baud rate in the field using simple DIP switch selection
- Captures alarm and trend history for faster troubleshooting
- Non-volatile memory retains point mappings and programs in the event of power loss.
- Approvals: BACnet Testing Labs (BTL) B-ASC on ProtoNode RER, CE Mark, LonMark 3.4 Certified on ProtoNode LER, TUV approved to UL 916

DIMENSIONS:

AERCO/ProtoNode-RER-E
(Serial Ethernet, P/N 64084)



AERCO/ProtoNode-LER
(LonWorks, P/N 64085)



SPECIFICATIONS:

64084:

- 1 - 6 pin Phoenix Connector
  - • 1 RS-485 +/- Ground port
  - • Power +/- Frame Ground port
- 1 - 3 pin Phoenix connector RS-485
  - • 1 RS-485 +/- Ground port
- 1 Ethernet -10/100 Ethernet port

64085:

- 1 - 6 pin Phoenix Connector
  - • 1 RS-485 +/- Ground port
  - • Power +/- Frame Ground port
- 1 - 3 pin Phoenix connector RS-485
  - • 1 RS-485 +/- Ground port
- 1 Ethernet -10/100 Ethernet port
- 1 FTT-10 LONWORKS port

Power Requirements..... 9-30 VDC or 9-24 VAC
Current draw @ 12V
64084..... @ 12V = 150 mA
64085..... @ 12V = 279 mA
Operating Temp..... -40ºF to 187ºF (-40ºC to 85ºC)
Relative Humidity ..... 5-90% RH, non-condensing
Dimensions..... 4.52 x 3.25 x 1.60 inches
Warranty ..... Two (2) years return to factory

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CG-1 11/2011 NY

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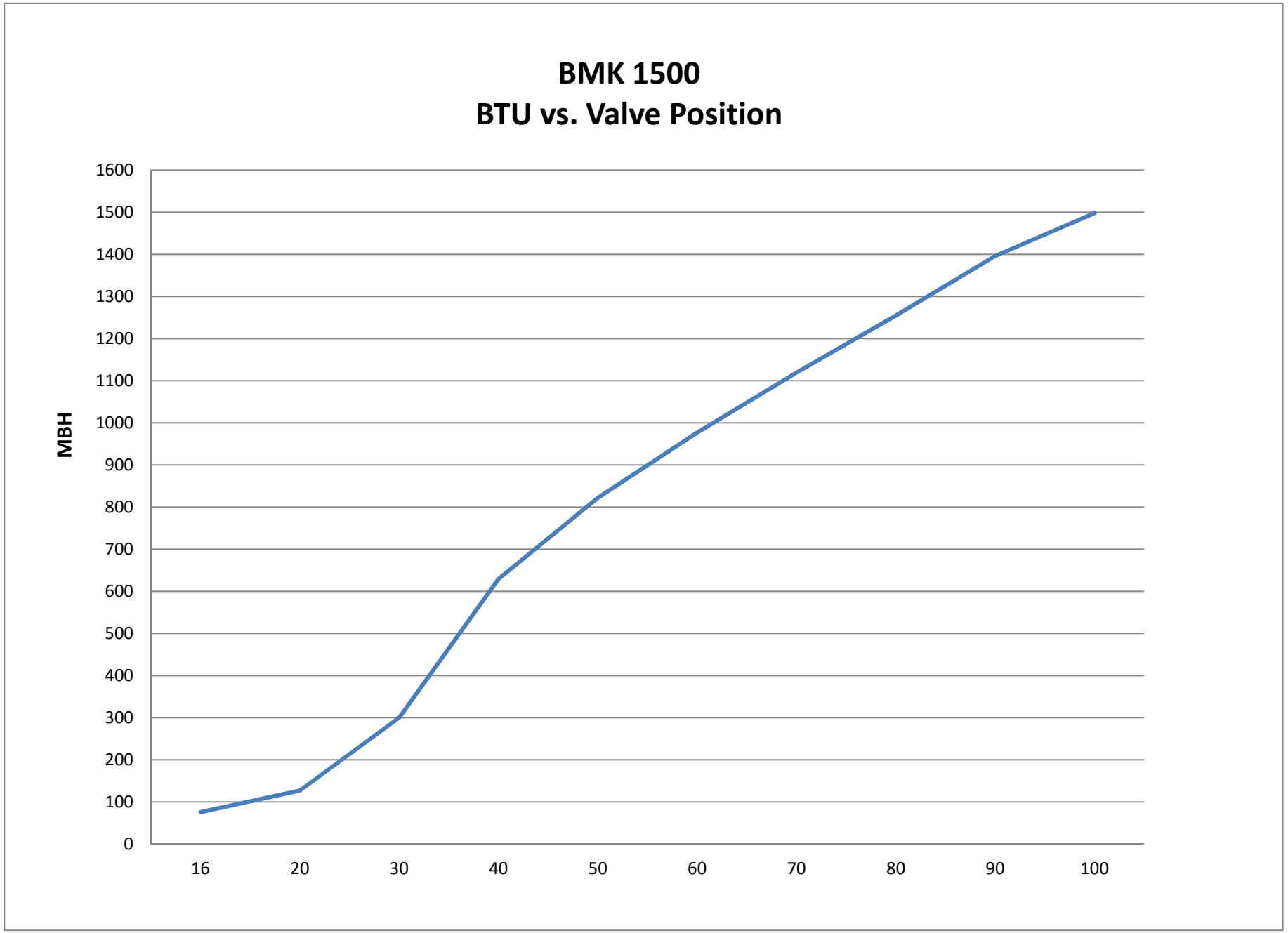
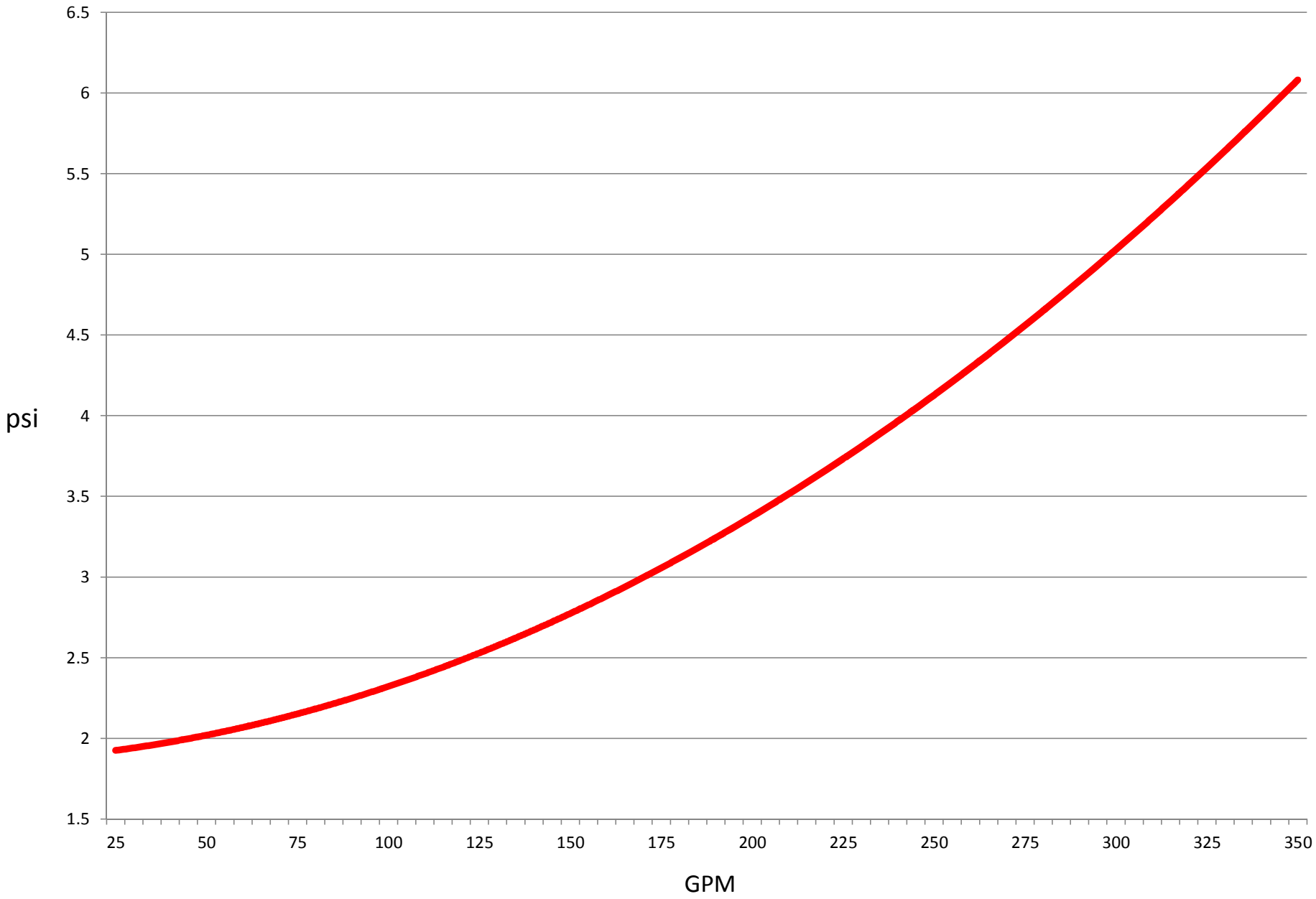
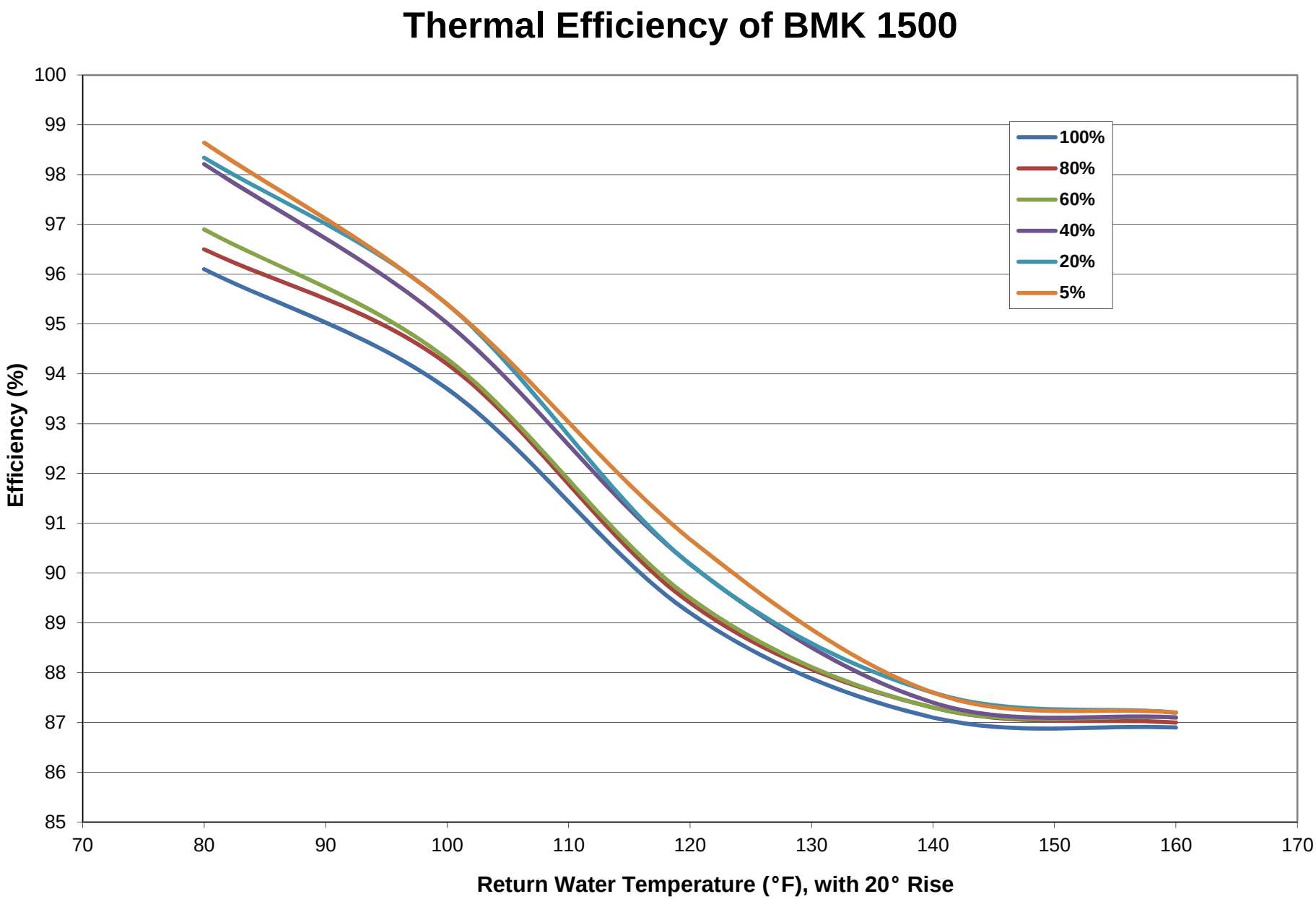
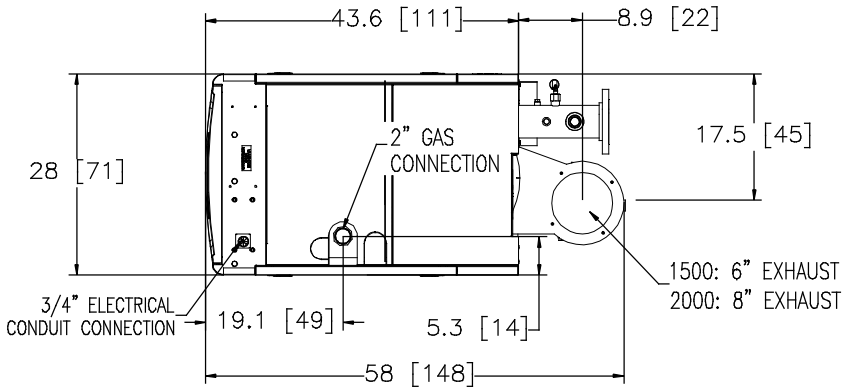

BMK 1500
BTU vs. Valve Position
MBH
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
16
20
30
40
50
60
70
80
90
100

BMK 1500 - 2000
Water Side Pressure Drop



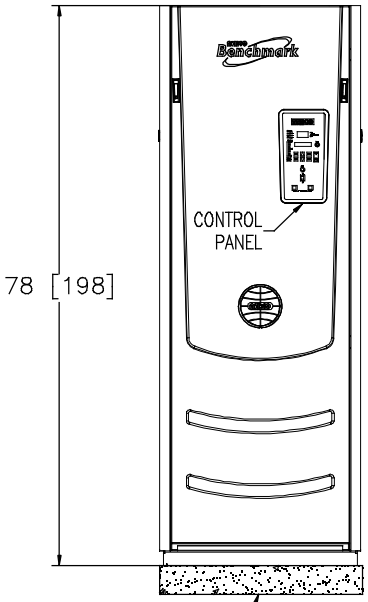

Thermal Efficiency of BMK 1500
Efficiency (%)
100
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
70
80
90
100
110
120
130
140
150
160
170
Return Water Temperature (°F), with 20° Rise
100%
80%
60%
40%
20%
5%

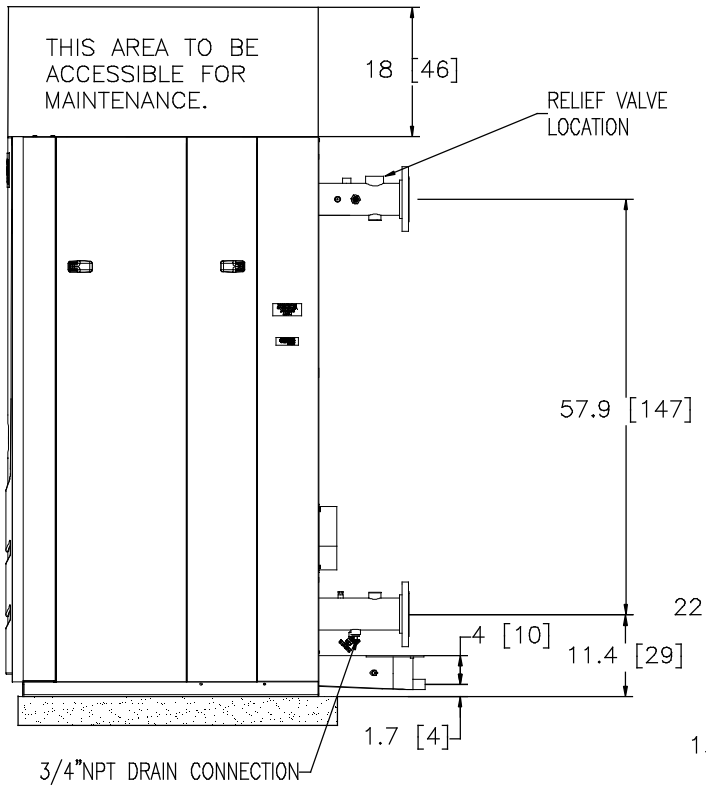


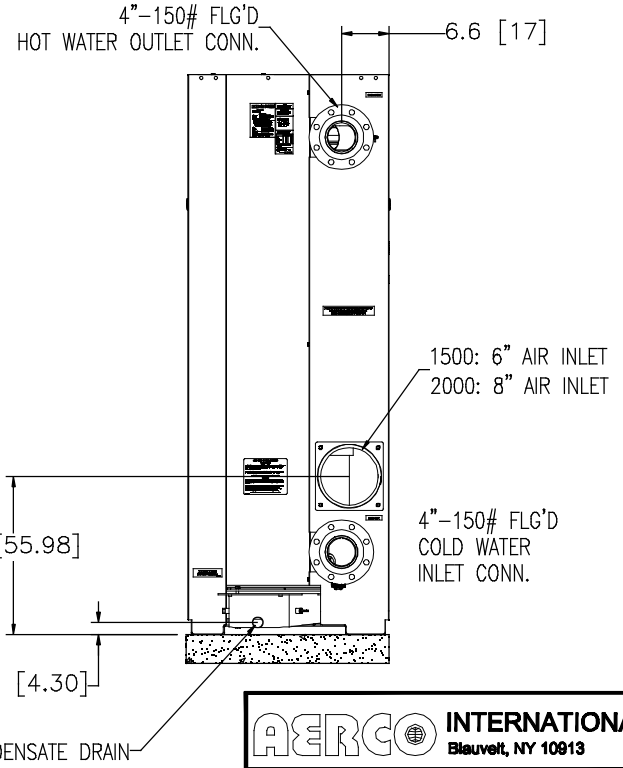
MATERIALS OF CONSTRUCTION	
COMBUSTION CHAMBER	SHELL OUTER–1/4" CARBON STEEL,SA–53 GR.B SHELL INNER–1/4"STAINLESS STEEL,SA–240, 439SS HEAD–1/2" CARBON STEEL,SA–516 GR.70 EXPANSION JOINT–1/4" STAINLESS STEEL,SA–240,439SS
HEAT EXCHANGER	UPPER TUBESHEET– 1/4" STAINLESS STEEL,SA–240,439SS LOWER TUBESHEET– 1/4" STAINLESS STEEL,SA–240,439SS TUBES–STAINLESS STEEL,9/16"O.D. X .049 WALL SA–249,439SS SHELL–1/4" CARBON STEEL,SA–53,GR.A OR B

HEAT EXCHANGERS & COMBUSTION CHAMBER DESIGN STANDARDS				
MAX. WORKING PRESS. (PSIG)	MAXIMUM TEMP. (°F)	TEST PRESS. (PSIG)	HT'G SURFACE SQ.FT.	MIN. RELIEF VA. CAPACITY MBH
160	210	240	107	1500
160	210	240	150	2000

ASME B & PV CODE: SECTION IV STAMP H







NOTES:
1) ALL DIMENSIONS SHOWN ARE IN INCHES (CENTIMETERS).
2) RELIEF VALVE, TRIDICATOR & CONDENSATE TRAP ARE INCLUDED SEPARATELY IN SHIPMENT.
3) AERCO RESERVES THE RIGHT TO MODIFY BOILER DIMENSIONS WITHOUT PRIOR NOTICE

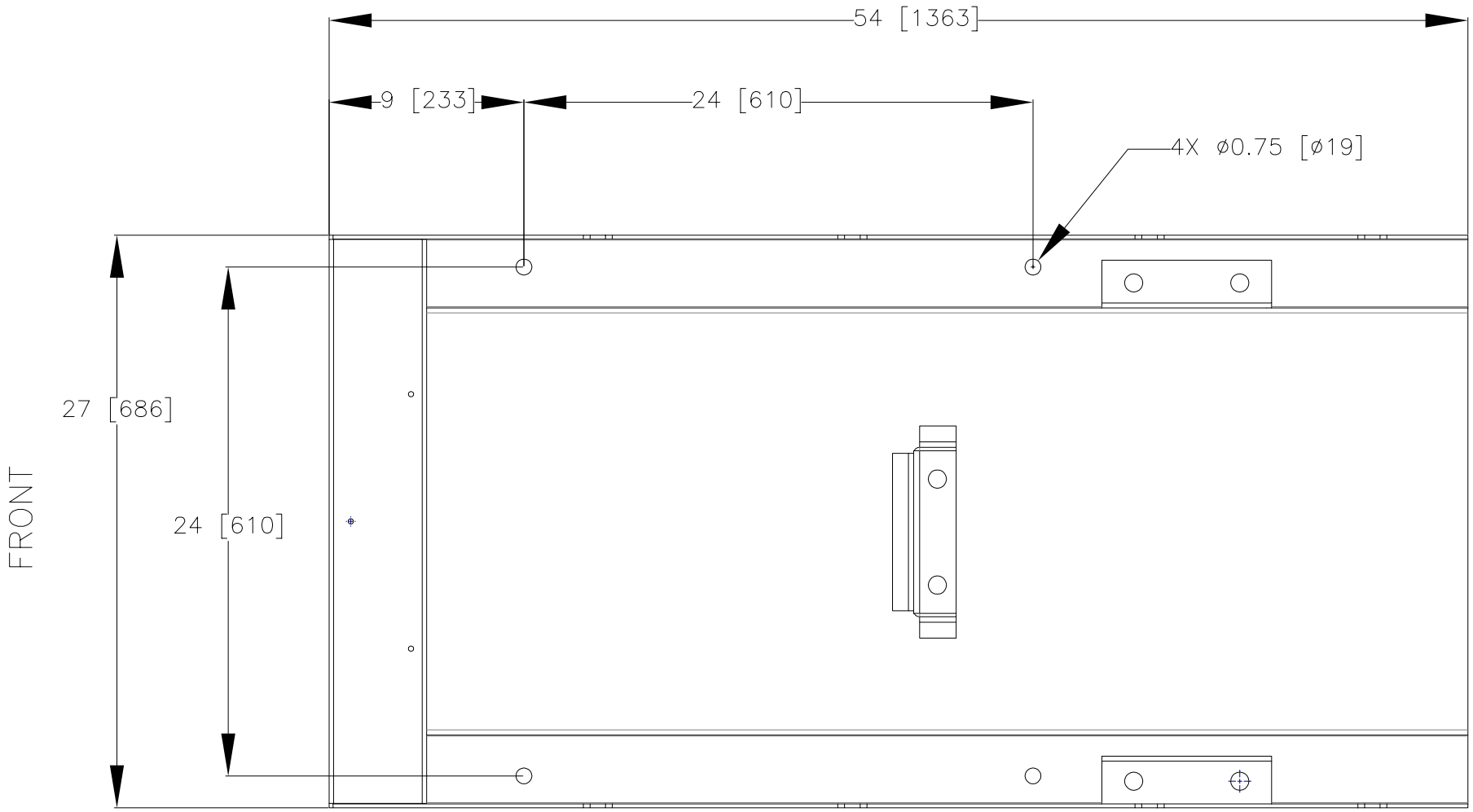
AERCO INTERNATIONAL, INC.
Blauvelt, NY 10913

BENCHMARK 1500 & 2000
GAS FIRED BOILER
DIMENSIONAL DRAWINGS

DWN.BY PR DATE 090313
SCALE ____ SIZE A
CHKD. ____ APPD. ____
REV.DATE ____

AP–A–936

REV. A



NOTES:
1) ALL HOLES ARE FLUSH WITH THE BOTTOM SURFACE OF THE FRAME
2) ALL DIMENSIONS SHOWN ARE IN INCHES (MILIIMETERS)

AERCO INTERNATIONAL, INC.
Blauvelt, NY 10913

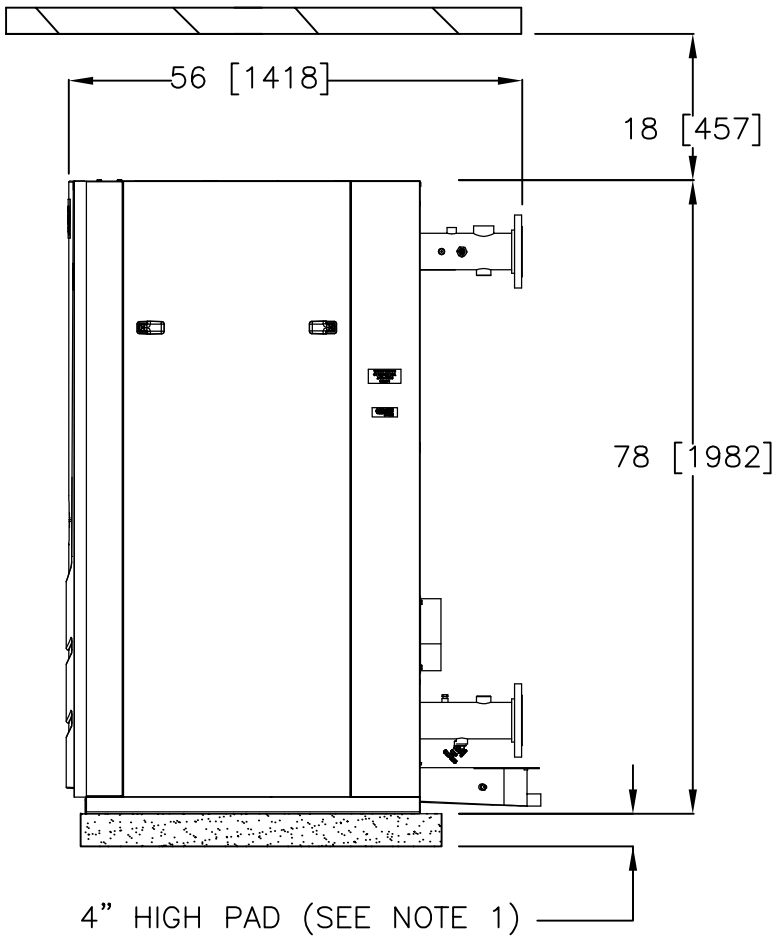
BENCHMARK 2000, 2500 & 3000 MBH
GAS FIRED BOILERS
ANCHOR BOLT LOCATION

DWN.BY PDR DATE 021512
SCALE NTS
APPD. _____ DATE _____

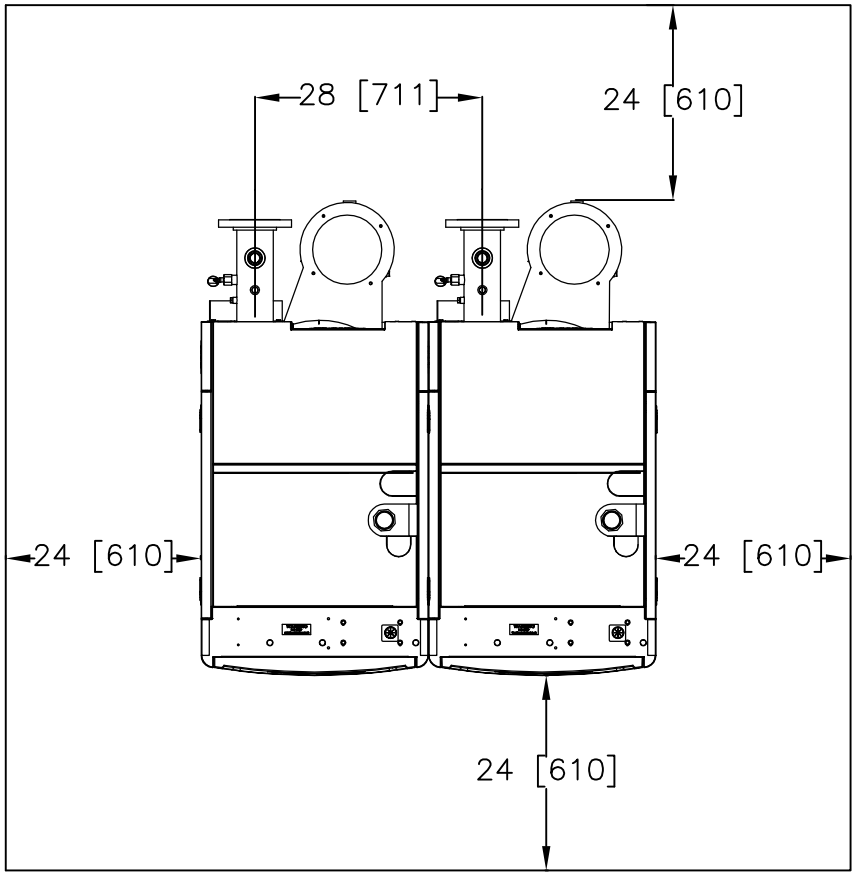
SD-A-896

REV C

SIDE VIEW



REAR



FRONT

INSTALLATION CLEARANCES:

1) THIS APPLIANCE MAY BE INSTALLED ON COMBUSTIBLE FLOORING
2) MINIMUM CLEARANCES TO ADJACENT CONSTRUCTION ARE AS FOLLOWS:
   LEFT & RIGHT SIDES: 24"
   FRONT: 24"
   REAR: 24"
   CEILING HIEGHT: 100"
3) DOOR PANEL REMOVAL NOT REQUIRED FOR ZERO SIDE CLEARANCE.

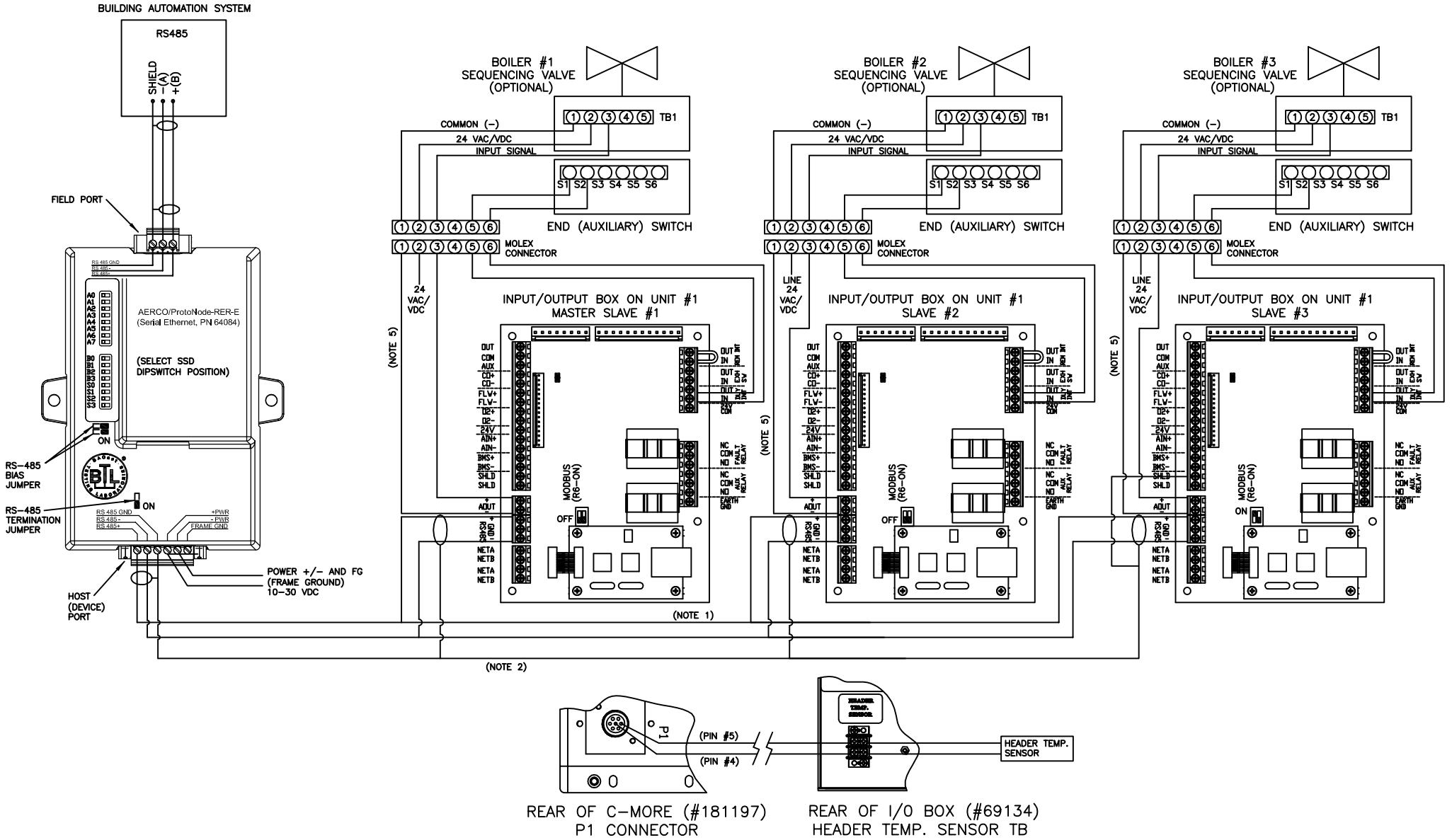
NOTE:
1. WHEN USING THE AERCO CONDENSATE NEUTRALIZER TANK, FOR PROPER CONDENSATE DRAINAGE, THE NEUTRALIZER TANK MUST BE INSTALLED IN A PIT OR THE BOILER AND THE AERCO CONDENSATE TRAP MUST BE ELEVATED HIGHER THAN 4" ABOVE THE FLOOR. SEE CONDENSATE TANK INSTRUCTIONS TID-0074 FOR DETAILS.

AERCO RESERVES THE RIGHT TO MODIFY BOILER DIMENSIONS WITHOUT PRIOR NOTICE

AERCO INTERNATIONAL, INC.
Blauvelt, NY 10913

BENCHMARK 1500-2000 MBH
GAS FIRED BOILER ZERO SIDE
CLEARANCE DRAWING

DWN. BY K.S. DATE 11/04/13 SCALE ____ APPD. ____ DATE ____	SD-A-996	REV A



NOTES:

1) WIRING TO BE SHIELDED TWISTED PAIR CABLE (BELDEN 9841 OR EQUIVALENT).
2) TERMINATE SHIELDS ON ONE I/O BOX ONLY (EITHER OF THE END UNITS OF THE CHAIN).
3) REMOVE COVER FROM PROTONODE AND PLACE RED "BIAS" JUMPERS IN THE "ON" POSITION AND THE BLUE "TERMINATION" JUMPER IN THE "ON" POSITION.
4) ON THE I/O BOARD INSIDE THE I/O BOX OF THE LAST UNIT ON THE CHAIN, TURN THE DIPSWITCH LABELED MODBUS (R6–ON) TO THE "ON" POSITION.
5) SEQUENCING VALVE POWER AND CONTROL WIRING IS SUPPLIED BY AERCO.
6) IF TERMINATION IS NEEDED AT FIELD PORT CONNECTION TO THE BUILDING AUTOMATION SYSTEM (BAS), ACTIVATE THE "END OF LINE" TERMINATION SWITCH (SW2) JUST BELOW THE FIELD PORT UNDER THE COVER. SEE GF–129 MANUAL FOR MORE DETAILED INFORMATION ON THE PROTONODE.

AERCO INTERNATIONAL, INC.
Blauvelt, NY 10913

C–MORE CONTROLS ONBOARD BOILER SEQUENCING TECHNOLOGY WITH PROTONODE AND BAS, FIELD WIRING DIAGRAM (24VAC)

DWN.BY K.S. DATE 022614 SCALE ____ SIZE A CHKD. ____ APPD. ____ REV.DATE ____	SD–A–1011	REV. A

MOV-02
Product Specification

BUTTERFLY MOTORIZED VALVE (AM/GM/GK/DKRX ACTUATOR) 24V

Valves are supplied by Belimo to AERCO's specification.

- 50 psi bubble tight shut-off
- Long stem design allows for 2" insulation
- Valve face-to-face dimensions comply with API 609 & MSS-SP-67
- Completely assembled and tested, ready for installation

Application

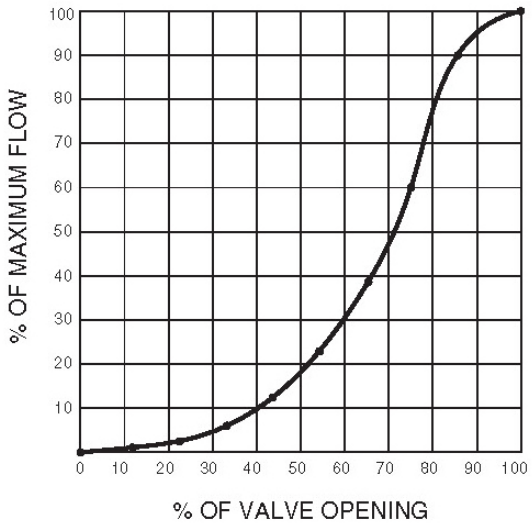
These valves are designed to meet the needs of HVAC and commercial applications requiring bubble tight shut-off for liquids. Typical applications include chiller isolation, cooling tower isolation, change-over systems, large air handler coil control, bypass and process control applications. The large Cv values provide for an economical control valve solution for larger flow applications.

Jobsite Note

Valves should be stored in a weather protected area prior to construction. Complete installation recommendations can be found in Belimo's Installationand Maintenance Instructions for F6/F7 HD/ HDU Butterfly Valves.

Valve Technical Data	
Service	chilled, hot water, 60% glycol
Flow Characteristic	modified equal percentage
Action	90° rotation
Type of End Fitting	for use with ANSI Class 125/150 flanges
Materials Body Body finish Disc Seat Shaft O-ring Upper bushing Middle bushings Lower bushing	 ductile iron ASTM A536 epoxy powder coated 304 stainless steel EPDM 416 stainless steel EPDM RPTFE RPTFE RPTFE
Media Temperature Range	-22°F to 250°F [-30°C to 120°C]
Operation Ambient Temperature Range	-22°F to 122°F [-30°C to 50°C]
Body Pressure Rating	ASME/ ANSI Class 125/150 (200 psi at -30°F to 275°F)
Rangeability	10:1 (for 30° to 70° range)
Maximum Velocity	12 FPS

Flow Pattern



Application Notes

1. Valves are rated at 50 psi differential pressure in the closed position.
2. Valves are furnished with lugs tapped for use with ANSI Class 125/150 flanges. Installation flanges and hardware are not included.
3. 2-way assemblies are furnished assembled and tested, ready for installation.

Actuator Technical Data	
Power Supply	24VAC ±20% 50/60Hz 24VDC ±10%
Power consumption AMX GMX GKX DKRX	Running (Holding) 3.5 W (1.3 W) 4.5 W (1.5 W) 12 W (3 W) 12 (3W)
Transformer sizing AMX GMX GKX/DKRX	 6 VA Class 2 power source 7 VA Class 2 power source 21 VA Class 2 power source
Electrical connection	18 GA plenum rated cable DKRX = Screw Terminal ½" conduit connector (for 22 to 12 AWG wire) protected NEMA 2 (IP54) 3 ft [1m]
Overload protection	electronic throughout 0 to 95 rotation (DKRX:90°)
Operation range Y	2 to 10 VDC, 4 to 20mA (default) variable (VDC,floating point, on/off)
Input impedance	100kΩ (0.1 mA), 500Ω 1500Ω (fl oating point, on/off)
Feedback output U	2 to 10VDC, 0.5mA max, VDC variable
Angle of rotation	max. 95° (DKRX 90°), adjustable with mechanical stop electronically variable
Torque AMX GMX GKX DKRX	 180 in-lb [20 Nm] 360 in-lb [40 Nm] 360 in-lb [40 Nm] 720 in-lb [80 Nm]
Direction of rotation	reversible with cw/ ccw switch
Fail-safe position (GKX/DKRX Models)	adjustable with dial or tool 0 to 100% in 10% increments
Position indication	reflective visual indicator (snap-on)
Manual override	external push button
Running time normal operation fail-safe (GKX/DKRX Models)	 90 seconds (default) , AMX variable (90 to 350 sec), GMX variable (75 to 300 sec), GKX variable (90 to 150 sec), DKRX=(75 to 290 sec) 35 seconds
Humidity	5 to 95% RH non-condensing
Ambient temperature	-22°F to +122°F [-30°C to +50°C]
Storage temperature	-40°F to +176°F [-40°C to +80°C]
Housing	NEMA2, IP54, UL enclosure type 2
Housing material	UL94-5VA(AMX/GMX/GKX); DKRX = Polycarbonate
Agency list	cULus acc. to UL 60730-1A/-2-14 (ALL MODELS) CAN/CSA E60730-1:02 (AMX/GMX/GKX); CAN/CSA E60730-1 (DKRX) Certified to IEC/EN 60730-1 and IEC/EN 60730-2-14" (DKRX) acc. to 2004/108/EEC and 2006/95/EC (AMX/GMX/GKX)
Noise level	max 45dB(A)
Servicing	maintenance free
Quality standard	ISO 9001

SPECIFICATIONS

AERCO P/N	Size	Valve Model	Actuator Model	Cv	Max GPM	COP	Weight (lbs)
92084-3	3"	F680HDU	AMX24-MFT	302	264	50	13
92084-4	4"	F6100HDU	GMX24-MFT	600	470	50	24
92084-5	3"	F680HDU	GKX24-MFT	302	264	50	15
92084-6	4"	F6100HDU	GKX24-MFT	600	470	50	25
92084-7	6"	F6150HDU	DKRX24-MFT-T	1579	1058	50	45

Represented By:

Specifications subject to change without prior notice.
Consult website or contact AERCO.
MOV-02 12/2012 NY

Operation

The actuator is electronically protected against overload.

The AMX, GMX, and GKX series actuators provide 95° (DKRX:90°) of rotation and a visual indicator shows the position of the actuator. When reaching the damper or actuator end position the actuator automatically stops. The gear can be manually disengaged by pressing the button located on the actuator cover.

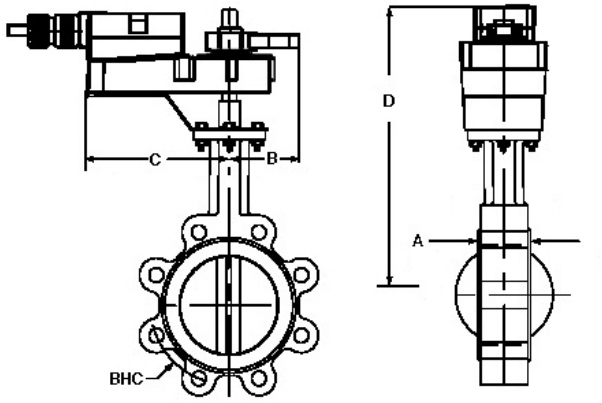
The AMX, GMX, GKX, and DKRX actuators use a brushless DC motor, which is controlled by an Application Specific Integrated Circuit (ASIC). The ASIC monitors and controls the actuators rotation and provides a digital rotation sensing (DRS) function to prevent damage to the actuator in a stall condition. Power consumption is reduced in a holding mode.

The GKX 24-MFT, and DKRX24-MFT acuator provides electrical power off operation for reliable fail safe application.

Auxiliary switches or feedback potentiometers are provided and fastened directly onto the actuator body for signaling and switching functions.

Complete wiring diagrams can be found in AERCO's Technical Instructions Document TID-0028.

DIMENSIONS



DIMENSIONS (INCHES)

AERCO	A	B	C	D (Max)	BHC	No. of Holes	Lug Bolt
92084-3	1.78	7	7	16	6	4	5/8-11UNC
92084-4	1.92	9	9	21	7.5	8	5/8-11UNC
92084-5	1.69	9	9	21.03	6	4	5/8-11UNC
92084-6	1.92	9	9	21.53	7.5	8	5/8-11UNC
92084-7	2.19	7.34	6.77	21.52	9.50	8	3/4-10UNC

Dimenson "A" is compressed, add .125" for relaxed state.

Dimension "D" allows for actuator removal without the need to remove the valve from the pipe.

Max GPM = Maximum US galllons of water per minute, at room temperature , that will flow through the fully open valve without exceeding design velocity limits.

COP = Close-Off Pressure stated in psi. This is the maximum differential pressure the valve will close-off against while maintaining a bubble tight seal.

PROPOSAL/SUBMITTAL INFORMATION

Size	AERCO P/N	System Data		
		GPM	Pressure (psig)	Temp (F)

WATER HEATERS • BOILERS • PARTS & ACCESSORIES
AERCO INTERNATIONAL, INC.
100 ORITANI DR. • BLAUVELT, NY 10913
(845) 580-8000 • FAX (845) 580-8090
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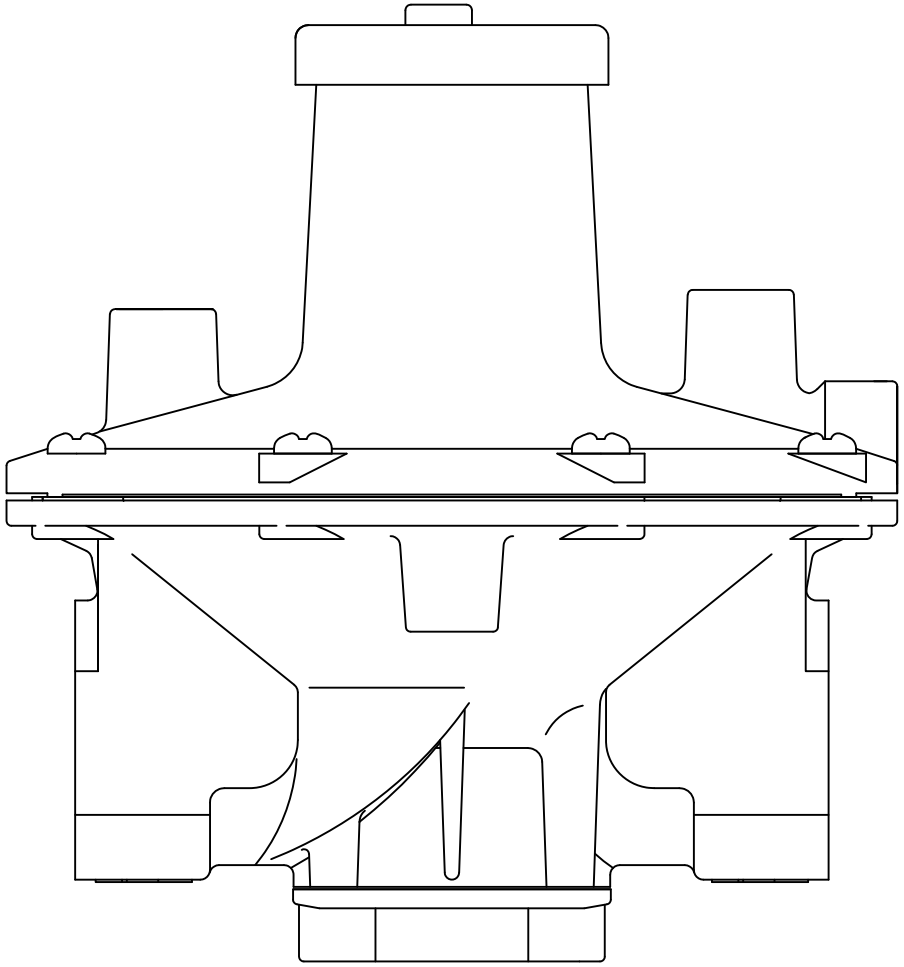


1–1/4" NPT GAS REGULATOR
JEAVONS J48
w/ RED / BLACK SPRING PT.NO. 70017P105
OUTLET PRESS. 5.0–10 IN. W.C.

AERCO INTERNATIONAL INC.
NORTHVALE, NEW JERSEY 07647

PART #:124259
EXTERNAL
GAS REGULATOR

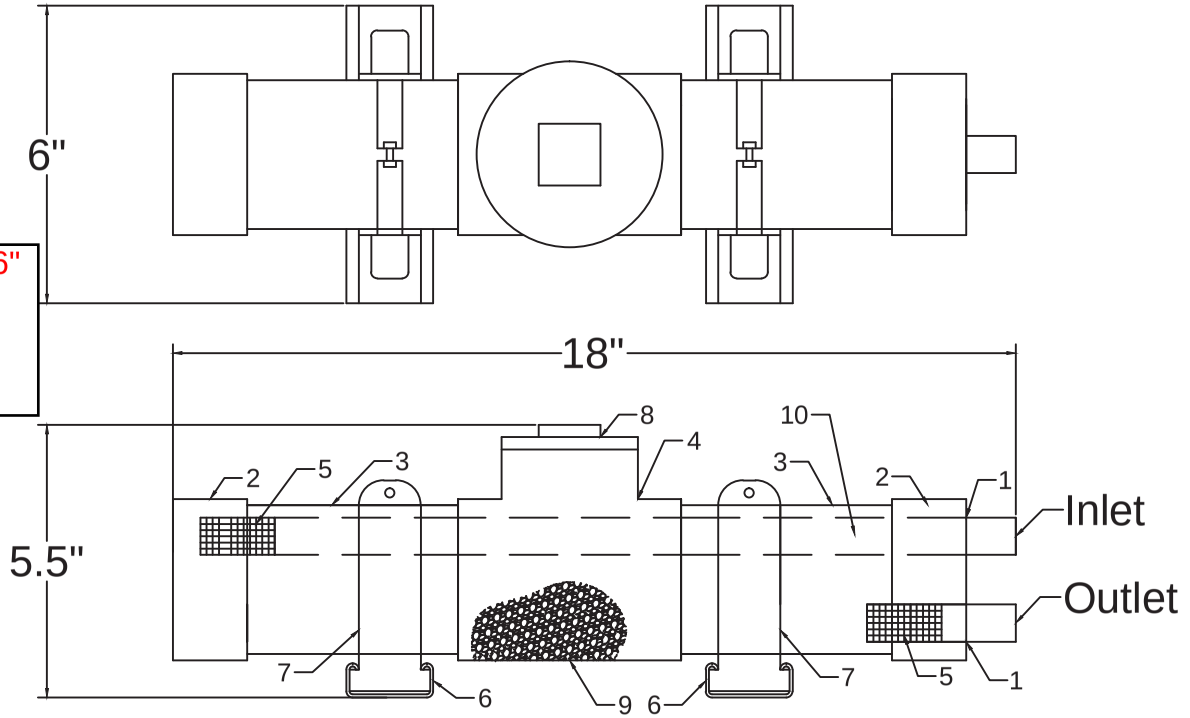
DWN BY CZ DATE 062403
SCALE NONE SIZE A
CHKD ____ APPD ____

SD–A–630

REV. B

Acidic Condensation Neutralization Kit

* Unions to be field installed within 6" of Inlet & Outlet.
* Field installed piping to be PVC, CPVC, or Stainless Steel.



Item	Description	Qty
1	¾ Schedule 40 PVC FM x FM Coupling	2
2	3" Schedule 40 PVC CAP (Modified)	2
3	3" Schedule 40 DWV-PVC Pipe	2
4	3" PVC-DWV Schedule 40 C/O Tee	1
5	¾" MIP Polypropylene Screen	2
6	14 Gauge 13/16" Painted Uni-Strut	2
7	Zinc Coated Uni-Strut Clamp	2
8	PVC-DWV MIP Threaded Cap	1
9	Limestone Formulated Mix	-
10	¾" PVC Schedule 40 Dip-Tube	1

- For use on High Efficiency Condensing Gas Fired Appliances
- Neutralizes flue gas condensation to a "Neutral 7.0" PH Level For Safe Disposal to drain and sewer
- Compliance with Michigan Plumbing Code Sections 803 & 314
- All connections prepaired with low "VOC" primer and PVC-Glue
- Active agent is crushed limestone & pelletized lime formulated mix
- Eliminates damage to concrete floors and cast iron drainage piping

Dimensions are Approximate
Patent Pending Design
Made in the U.S.A

BKI INDUSTRIES, INC.

Model: BKI-2000

BTU Capacity: Up to 2000 MBH

Est. Weight: 14 lbs

www.bkiindustries.com

BKI Industries, Inc

P.O. Box 256 Walled Lake, MI 48390

Phone: 248-977-5550 Fax: 248-438-1674

Approved by:	Scale: None
Date: 11-9-11	Revision: 1.1

ITT

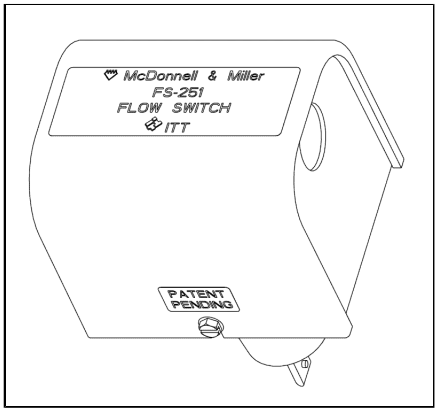
SUBMITTAL

MM-627

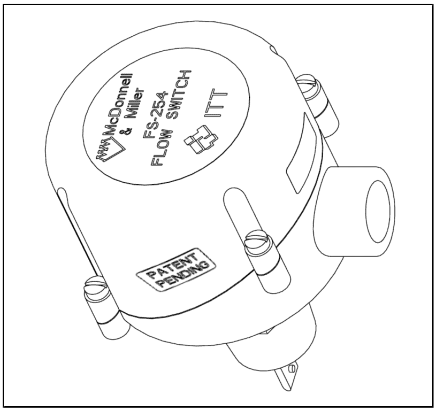
JOB:	**REPRESENTATIVE:**	
UNIT TAG:	**ORDER NO.**	**DATE:**
ENGINEER:	**SUBMITTED BY:**	**DATE:**
CONTRACTOR:	**APPROVED BY:**	**DATE:**

Series FS250 General Purpose Liquid Flow Switches

FS251



FS254



Materials of Construction	
Part	**Specifications**
Wetted Body	Brass
Paddle arm	Brass
Pivot Pin	Brass
O-ring	EPDM
Paddles	Stainless Steel
Housing Base	
FS251	Aluminized Steel
FS254	Aluminum
Housing Cover	
FS251	Polycarbonate
FS254	Aluminum

Ratings	
FS251	NEMA-1
FS254	NEMA-4
Maximum Operating Pressure	160 psig (11.0 bar)
Maximum Temperature	250°F (121 °C)

	Motor Switch Rating (Amperes)		
Voltage	**Full Load**	**Locked Rotor**	**Pilot Duty**
120VAC	7.4	44.4	125 VA at 120 or 240 VAC 50 or 60 cycles
240 VAC	3.7	22.2	

Pipe Size NPT (in.)	Flow Adjustment Setting	Series FS250 Flow gpm (lpm)	No Flow gpm (lpm)	Max Flow Rate (gpm) (lpm)†
1"	Minimum	5.8 (22)	5.1 (19)	27
	Maximum	12.6 (48)	11.9 (45)	(102)
1-1/4"	Minimum	6.7 (25)	6.0 (23)	47
	Maximum	19.1 (72)	18.0 (68)	(178)
1-1/2"	Minimum	8.4 (32)	7.0 (26)	63
	Maximum	25.3 (96)	24.1 (91)	(238)
2"	Minimum	12.9 (49)	11.2 (42)	105
	Maximum	31.5 (119)	30.2 (114)	(397)
2-1/2"	Minimum	17.9 (68)	14.5 (55)	149
	Maximum	43.2 (164)	40.0 (151)	(564)
3"	Minimum	26.2 (99)	20.2 (76)	230
	Maximum	54.9 (208)	49.8 (188)	(871)
4"	Minimum	42.0 (159)	33.7 (128)	397
	Maximum	75.6 (286)	68.0 (257)	(1503)
5"	Minimum	54.6 (207)	46.7 (177)	654
	Maximum	109.4 (414)	98.4 (372)	(2475)
6"	Minimum	67.7 (256)	60.2 (228)	900
	Maximum	131.1 (496)	123.5 (467)	(3407)

† Without Paddle Damage

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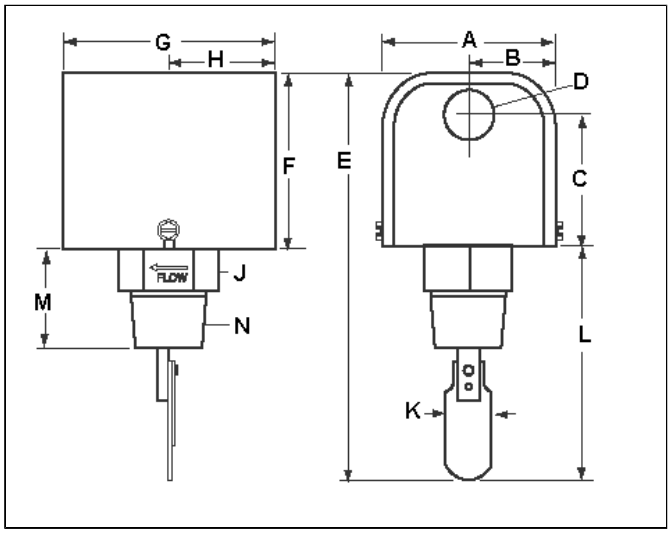
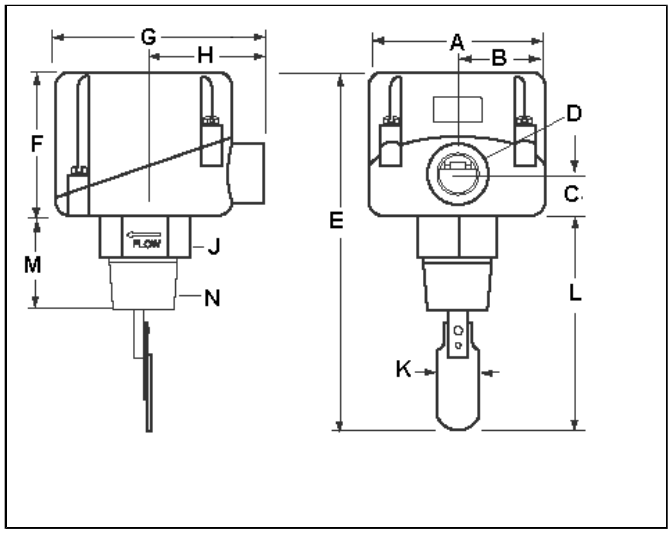
McDonnell & Miller

Series FS250 Dimensions

FS251



FS254



Dimensions		
Reference	**FS251**	**FS254**
A	3 (76)	3-1/4 (83)
B	1-1/2 (38)	1-5/8 (41)
C	2-7/32 (56)	3/4 (19)
D	7/8 (22)	1/2 NPTF
E	6-3/8 (162)	6-3/16 (157)
F	2-15/16 (75)	2-3/4 (70)
G	3-3/8 (86)	3-7/8 (98)
H	1-11/16 (43)	2-1/4 (57)
J	1-1/2 (38)	1-1/2 (38)
K	1-1/8 (29)	1-1/8 (29)
L (with 1" paddle)	3-7/16 (87)	3-7/16 (87)
M	2-1/16 (52)	1-7/8 (48)
N	1" NPTM	1" NPTM
P Turn-in Radius (not shown)	2-5/16 (59)	2-5/16 (59)

ITT
8200 N. Austin Avenue
Morton Grove, IL 60053
Phone (847)966-3700
Facsimile (847)966-9052
www.mcdonnellmiller.com

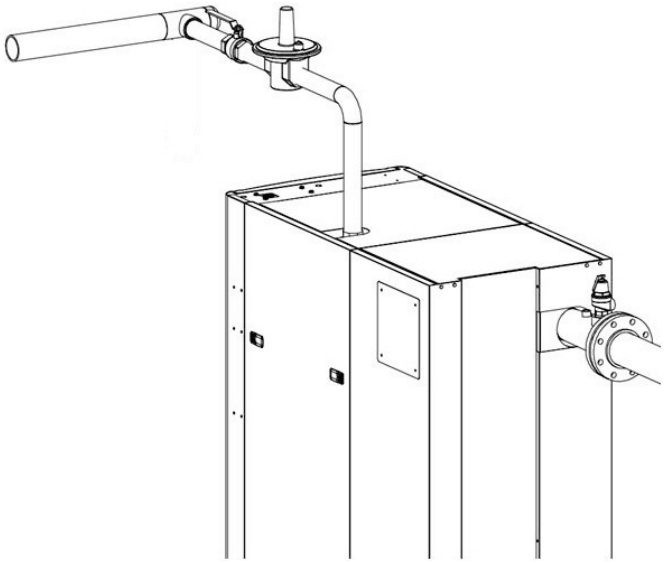
GAS SUPPLY DESIGN GUIDE

Natural Gas, Propane Gas, or Dual Fuel Fired Modulating, Condensing Boilers

For models:

BMK750 to BMK6000

BENCHMARK Series
Gas-Fired Boilers



Last Update: 10/04/2013

Technical Support:
(Mon–Fri, 8am-5pm EST)
1-800-526-0288

www.aerco.com

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GENERAL

AERCO Benchmark Low NOx gas fired boilers are modulating input devices that require an adequate volume of natural gas at constant pressure for proper operation. The gas requirements specified in this document must be satisfied to ensure efficient combustion. Designers and installers must adhere to the AERCO specifications and those of the local authorities having jurisdiction. A thorough understanding and knowledge of these guidelines is required for the successful design and installation of Benchmark Low NOx series boilers.

Gas Train Components

AERCO Benchmark gas-fired boilers are equipped with standard UL approved/FM compliant gas trains. These gas trains are factory tested and fired, with a minimum number of modular components. The gas train components have been designed to operate at high combustion efficiencies by closely controlling both the volume and air/fuel mixture to the burner. The major internal gas train components are:

- **SAFETY SHUT OFF VALVE (SSOV) With BUILT-IN SUPPLY GAS REGULATOR** - An electro-hydraulic gas valve, containing a proof of closure switch, is utilized to stop fuel from flowing into the gas train of the boiler. This is a 100% tight shutoff device with a visible window indicator showing valve position. Reliable, and a standard industry component, this valve is factory piped with a low gas pressure switch on the inlet side of the valve which monitors the manifold pressure for minimum supply conditions. There is also a high gas pressure switch installed on the outlet side of the gas valve, which shuts down the boiler if gas manifold pressures exceed maximum conditions. On all BMK750 to BMK 3000 models, the actuator has a built-in regulator that replaces the need for an external supply regulator for installations that have supply pressure of up to 14.0" W.C. This does not apply to the BMK 6000 units, which have a *minimum* supply pressure of 14" W.C. For installations that have supply pressure greater than 14.0" W.C., see the **"Gas Pressure Requirements**" section.

- **AIR/FUEL VALVE** - The air/fuel valve controls the volume and mixture of air and fuel in perfect proportion throughout the entire modulation range of the boiler. The valve utilizes one common shaft to simultaneously vary the gas port area and air volume. The gas portion of the valve is a slide port type valve with linear proportion-to-position characteristics. The air side uses a butterfly type valve for adjusting the air volume. The driver of the valve shaft is a precision stepping motor which provides continuous positioning from full input to minimum fire. The air/fuel valve also contains two proof-of-position switches.

- **CAST ALUMINUM BLOWER ASSEMBLY** - A cast aluminum pre-mix blower ensures the precise mixing of air and fuel prior to entering the burner thereby providing controlled combustion.

* **LOW NOx BURNER** – The burner provides the actual point of air/fuel contact and combustion into the cylindrical combustion/heat exchanger. Fabricated from metal fiber mesh covering a stainless steel body, the burner is stable throughout the entire input range of the boiler. The spark igniter and flame detector for the combustion supervision system are part of this assembly. The burner is easily removable from the boiler.

GAS PRESSURE REQUIREMENTS

AERCO Benchmark Low NOx series boilers require a stable natural gas and propane input pressure. For Benchmark Models BMK 750 through BMK 3000, the nominal inlet supply pressure to the boiler is 7.0" W.C. The allowable gas inlet pressure range is 4.0" W.C. (min.) to 14.0" W.C. (max.) when firing at maximum input, except for the BMK 750 and BMK 1000 when operating with propane, in which case the minimum propane inlet pressure is 7.0" W.C. for the BMK 750 and 10.0" W.C. for the BMK 1000. A low supply gas pressure switch in each gas train prevents the boiler from operating without sufficient pressure. Maximum allowable gas pressure is 14.0" W.C. for BMK 750 through BMK 3000 boiler sizes. Gas pressure should be measured when the unit is in operation (firing). Measure the gas pressure with a manometer at the 1/8" NPT ball valve provided at the SSOV inlet. In a multiple boiler installation, gas pressure should initially be set for single boiler operation, and then the remaining boilers should be staged on at full fire, to insure gas pressures never fall below the supply gas pressure when the single unit was firing.

The Benchmark BMK 6000 Model requires a minimum stable gas pressure of 14" W.C. The maximum allowable gas pressure for the BMK 6000 is 2.0 psig. As with all other BMK sizes, a low supply gas pressure switch is provided in the gas train to prevent operation without sufficient gas pressure.

An external isolation valve must be installed at each Benchmark Low NOx boiler, as shown in Diagram 1. This isolation valve is supplied with the boiler. For installations that have greater than 14.0" W.C. supply pressure, an external lock-up type regulator must be installed downstream of the isolation valve. The lock-up type regulator(s) must be sized as follows

Boiler Size (MBH)	Required CFH
750	750 – 850
1000	1000 – 1200
1500	1500 – 1750
2000	2000 – 2300
2500	2500 – 2850
3000	3000 – 3400
6000	6000 – 6500

External gas regulators are self-contained with tapped diaphragm vent ports allowing the diaphragm to change its position as required. These vents typically require piping to the outside. For details, refer to the paragraph titled "**Venting of Gas Supply Regulators"** on page 9 of this guide. The SSOV/Regulator in the gas train is factory piped and does not require any vent piping.

⚠ CAUTION ⚠

AERCO BOILERS MUST BE ISOLATED FROM THE SYSTEM WHEN LEAK TESTING.

Drip legs are typically required at the gas supply of each boiler to prevent any dirt, weld slag, or debris from entering the boiler gas train inlet pipe. When multiple boilers are installed, some utilities and local codes require a full size drip leg on the main gas supply line in addition to the drip leg at each unit. The bottom of the gas drip leg(s) should be removable without disassembling any gas piping. The weight of the gas pipe should not be supported from the bottom of the drip leg. The drip leg(s) should not be used to support any or part of the gas piping.

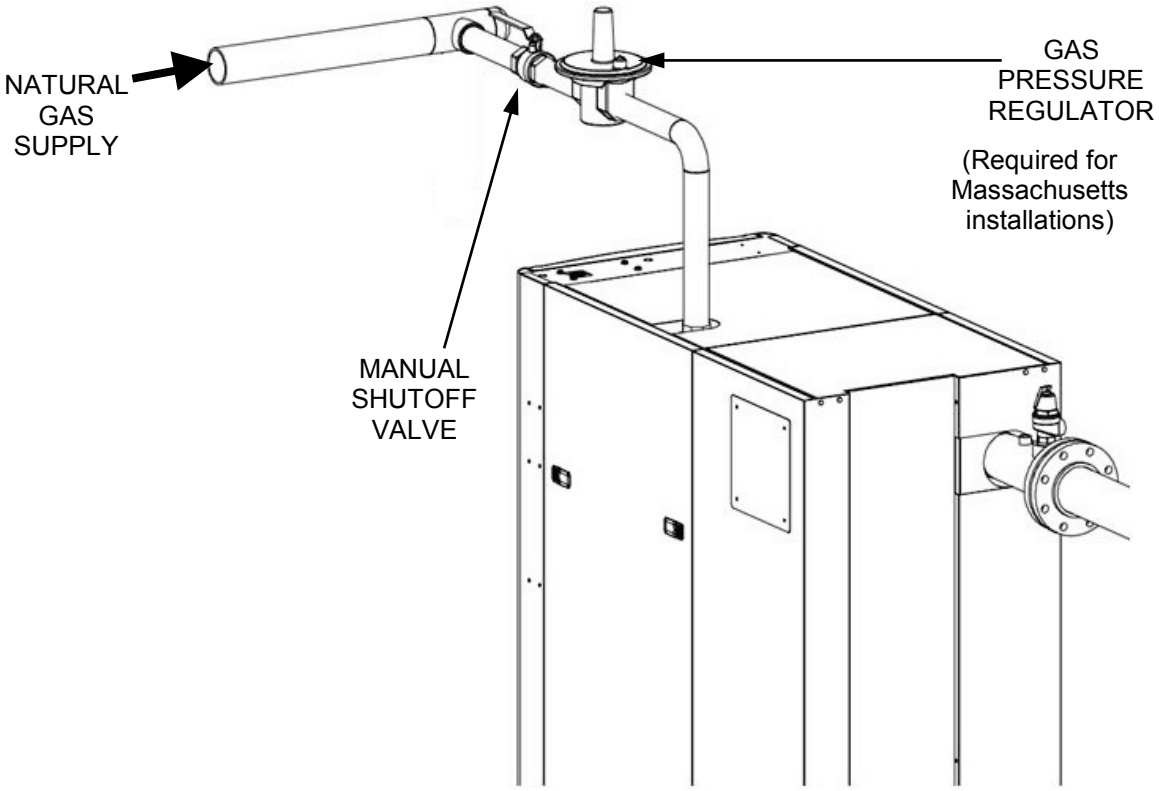

Diagram 1. Single Boiler Gas Pipe Connections (BMK 2000 Shown)

CUSTOM GAS TRAINS

Some utilities, insurance carriers, and industrial customers have special requirement gas components on high input devices beyond that which are normally supplied with AERCO boilers. Secondary shutoffs, high or low pressure operators, and external regulators are typical of the requirements of gas utilities. It is mandatory that a designer or installer comply with these requirements. AERCO assumes no liability when these requirements are not satisfied for any location or installation. Contact your local gas utility for their specific requirements before installing AERCO equipment. Special gas trains with a double block and bleed (DBB) configuration (formerly IRI) are available from AERCO.

The minimum gas inlet pressure requirements for natural gas (N.G.) and propane (LPG) are as follows:

Minimum Gas Inlet Pressure Requirements for Natural Gas and Propane

	BMK 750		**BMK 1000**		**BMK 1500**		**BMK 2000**		**BMK 2500**		**BMK 3000**		**BMK 6000**	
Gas Train	N.G.	LPG	N.G.	LPG	N.G.	LPG	N.G.	LPG	N.G.	LPG	N.G.	LPG	N.G.	LPG
DBB (IRI)	4.5" W.C.	7" W.C.	4.5" W.C.	10" W.C.	4.5" W.C.	---	5.0" W.C.	5.0" W.C.	4.5" W.C.	4.5" W.C.	4.5" W.C.	4.5" W.C.	14" W.C.	10.5" W.C.
Dual Fuel	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4" W.C.	8" W.C.	14" W.C.	10.5" W.C.
Dual Fuel DBB (IRI)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4" W.C.	8" W.C.	14" W.C.	10.5" W.C.

GAS PIPING

All gas piping and components must comply with NFPA local codes, and utility requirements minimum. Only gas approved fittings, valves, or pipe should be utilized.

Standard industry practice for gas piping is Schedule 40 iron pipe and fittings. All high and low gas pressure piping systems must comply with local utility and building codes.

Assembled piping should be clean of all debris, pipe chips, or foreign material to prevent any from entering the Innovation Low NOx series boiler gas train. Piping should be tested as prescribed in NFPA 54. Equipment should be isolated before testing any piping system over the allowable pressure. *DO NOT EXCEED 14.0" W.C.* on the inlet side of the Benchmark boiler at any time for BMK 750 through BMK 3000 Models. For BMK 6000 boilers, DO NOT EXCEED 2.0 P.S.I. on the inlet side of the boiler at any time.

GAS SUPPLY MAIN SIZING

Gas pipe sizing, for either a single or multiple boiler installation, shall be sized for a **maximum pressure drop of 0.3" W.C., from the source to the final boiler**. The maximum gas flow rate required is the sum of the maximum inputs of each unit divided by the heat of combustion of the fuel supplied at the location, (approximately 1,030 BTU per cubic foot for natural gas or 2,520 BTU per cubic foot for propane gas). The fuel supplier or utility should be consulted to confirm that sufficient volume and normal pressure is provided to the building at the discharge side of the gas meter or supply pipe. For existing installations with gas equipment, gas pressure should be measured with a manometer to be certain sufficient pressure is available. Before sizing gas piping, a survey of all connected gas devices should be made. Gas piping supplying more than one gas device must be able to handle the total connected input within the allowable gas pressure drop. The allowable minimum and maximum gas pressure for each device should be considered. Whenever the minimum and maximum gas pressures vary between devices, gas pressure regulators at each unit should be installed to allow regulation at any individual unit. Gas pressure must never exceed the maximum allowable rating of any connected device.

The total length of gas piping as well as fitting pressure drop must be considered when sizing the gas piping. Total equivalent length should be calculated from the meter or source location to the last boiler connected on the header. The Gas Piping Tables 1, 2 and 3 (see below) containing data extracted from NFPA 54 should be used as *a minimum guideline*. Gas pipe size should be selected on the total *equivalent* length from the appropriate pressure table. The gas volume for cfh flow will be the input divided by the calorific value of the fuel to be supplied.

GAS HEADER SIZING

Main supply gas pipe sizing should be developed for the total plant. Boiler gas manifold piping should be sized based on the volume requirements and lengths between boilers and the fuel main. Multiple boiler manifold sizing (Diagram 2) indicates the proper sizing for units placed on the factory standard 52" centers with 2" takeoffs for each unit. Header sizes can be either full size or stepped in size as units are connected. A typical gas piping header diagram for a 3-Module Benchmark Boiler Plant is illustrated in Diagram 3.

BENCHMARK SERIES GAS HEADER SIZING								
No. of Boilers	1	2	3	4	5	6	7	8
Sch. 40 Iron Pipe	2"	4"	4"	4"	5"	5"	6"	6"

Diagram 2. Multiple Boiler Manifold Chart *

***** Depending on gas piping layout. See Gas Piping Tables 1 – 4, below.

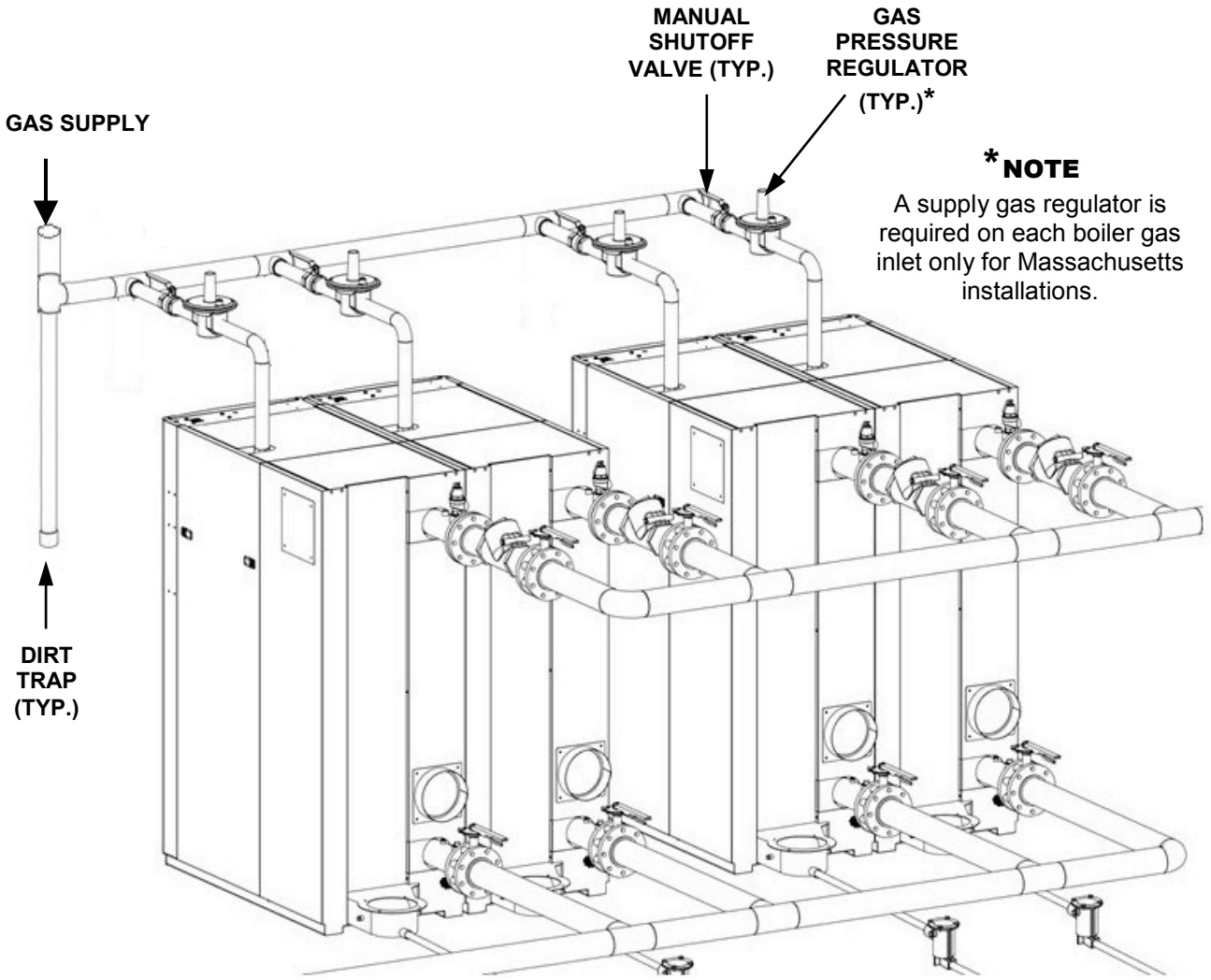
MANUAL SHUTOFF VALVE (TYP.)
GAS PRESSURE REGULATOR (TYP.)*
GAS SUPPLY
*NOTE
A supply gas regulator is required on each boiler gas inlet only for Massachusetts installations.
DIRT TRAP (TYP.)

Diagram 3: Typical Multiple Boiler Manifold Construction

*Based on Table 1 on the following page for natural gas, 0.6 specific gravity, 1,000 cfh/unit, actual header sizes will vary with length of pipe run and fittings employed. For propane gas (1.6 specific gravity, 2,520 BTU/FT3) header sizing, consult NFPA 54.

If supply gas pressure exceeds 14.0" W.C., a single header gas manifold lock-up type regulator, -or- individual lock-up regulators can be used to bring the gas pressure down to 14.0" W.C. Header should be located above or behind boiler. Gas piping should not be installed directly over top or front of any part of boiler. Sufficient clearances for maintenance are required.

GAS PIPING TABLES

The data in the following pipe and vent sizing tables have been extracted from the National Fire Protection Association Article 54 (NFPA 54)

TABLE 1

Maximum Capacity of Pipe in Cubic Feet of Gas per Hour for Gas Pressures of 0.5 psi or Less and a Pressure Drop of 0.3 inch Water Column

Nominal Iron Pipe Size (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe (Feet)												
		10	20	30	40	50	60	70	80	90	125	150	175	200
2.00	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	990	930	780	710	650	610
2.50	2.469	4,800	3,300	2,700	2,300	2,000	1,850	1,700	1,600	1,500	1,250	1,130	1,050	980
3.00	3.068	8,500	5,900	4,700	4,100	3,600	3,250	3,000	2,800	2,600	2,200	2,000	1,850	1,700
4.00	4.026	17,500	12,000	9,700	8,300	7,400	6,800	6,200	5,800	5,400	4,500	4,100	3,800	3,500

TABLE 2

Pipe Sizing Table for 1 Pound Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 1.0 psi with a 10% Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe (Feet)							
		50	100	150	200	250	300	400	500
2.00	2.067	4245	2918	2343	2005	1777	1610	1378	1222
2.50	2.469	6766	4651	3735	3196	2833	2567	2197	1947
3.00	3.068	11962	8221	6602	5650	5008	4538	3884	3442
3.50	3.548	17514	12037	9666	8273	7332	6644	5686	5039
4.00	4.026	24398	16769	13466	11525	10214	9255	7921	7020
5.00	5.047	44140	30337	24362	20851	18479	16744	14330	12701
6.00	6.065	71473	49123	39447	33762	29923	27112	23204	20566
8.00	7.981	146849	100929	81049	69368	61479	55705	47676	42254

TABLE 3

Pipe Sizing Table for 2 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 2.0 psi with a 10% Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe (Feet)							
		50	100	150	200	250	300	400	500
2.00	2.067	6589	4528	3636	3112	2758	2499	2139	1896
2.50	2.469	10501	7217	5796	4961	4396	3983	3409	3022
3.00	3.068	18564	12759	10246	8769	7772	7042	6027	5342
3.50	3.548	27181	18681	15002	12840	11379	10311	8825	7821
4.00	4.026	37865	26025	20899	17887	15853	14364	12293	10895
5.00	5.047	68504	47082	37809	32359	28680	25986	22240	19711
6.00	6.065	110924	76237	61221	52397	46439	42077	36012	31917

TABLE 4

Pipe Sizing Table for 5 Pounds Pressure Capacity of Pipes of Different Diameters and Lengths in Cubic Feet per Hour for an Initial Pressure of 5.0 psi with a 10% Pressure Drop and a Gas of 0.6 Specific Gravity

Pipe Size of Schedule 40 Standard Pipe (Inches)	Internal Diameter (Inches)	Total Equivalent Length of Pipe (Feet)							
		50	100	150	200	250	300	400	500
2.00	2.067	11786	8101	6505	5567	4934	4471	3827	3391
2.50	2.469	18785	12911	10368	8874	7865	7126	6099	5405
3.00	3.068	33209	22824	18329	15687	13903	12597	10782	9556
3.50	3.548	48623	33418	26836	22968	20365	18444	15786	13991
4.00	4.026	67736	46555	37385	31997	28358	25694	21991	19490
5.00	5.047	122544	84224	67635	57887	51304	46485	39785	35261
6.00	6.065	198427	136378	109516	93732	83073	75270	64421	57095

VENTING OF GAS SUPPLY REGULATORS

AERCO's general guidelines for venting of gas regulators are listed below. AERCO recommends that these guidelines be followed to ensure the most reliable and proper operation of AERCO gas fired equipment. It is also recommended that you consult local codes and the gas regulator manufacturer for additional details. Always follow the most stringent guidelines available, including those listed below.

- When venting a gas supply regulator, the vent pipe must be no smaller than the regulator vent size.
- In a multiple unit installation, each regulator must have a separate vent line.
- Vent lines must not be manifolded together or with any other equipment at the site that also requires atmospheric vents.
- When sizing the vent, pipe diameters must be increased by one pipe diameter every 20 equivalent feet of pipe.

Each 90° elbow is equivalent to approximately:

⇒ 2.5 feet for nominal pipe sizes of up to 3/4"

⇒ 4.5 feet for nominal pipe sizes of up to 1-1/2"

⇒ 10.5 feet for nominal pipe sizes of up to 4"

Each 45° elbow is equivalent to approximately:

⇒ 1 foot for nominal pipe sizes of up to 3/4"

⇒ 2 feet for nominal pipe sizes of up to 1-1/2"

⇒ 5 feet for nominal pipe sizes of up to 4"

Change Log

Date	Description	Changed By
09/03/2013	Rev F: Removed refs to BMK1.5/2.0, changed all images, added references to 1500, 2000, 2500 units.	Curtis Harvey
10/04/2013	Rev G: Modified 2 drawings to remove multiple dirt traps (installations have 1 dirt trap per gas input line, not per unit) per PIR 936.	Chris Blair

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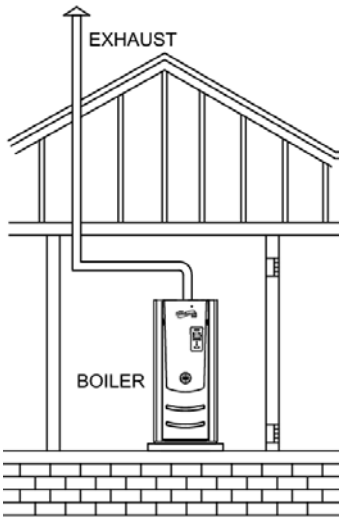
VENTING AND COMBUSTION AIR GUIDE

Natural Gas, Propane Gas, or Dual Fuel Fired Modulating, Condensing Boilers

For models:

BMK 750 to BMK 6000

Benchmark Series
Gas Fired Boilers



Revised: 12/03/2013

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Table of Contents

1.1 General 4
1.2 Materials and Approvals 4
1.3 Code Required Vent Terminations 4
1.4 Combustion Air Supply 6
1.5 Combustion Air from WITHIN the Building 7
1.6 Combustion Air from OUTSIDE the Building 8
1.7 Two-Permanent-Openings Method (USA Only) 8
1.8 One Permanent Opening Method 11
1.9 Opening a Louver Through the Benchmark Boiler 12
1.10 Direct Vent/Ducted Combustion Air 13
1.11 Exhaust Vent and Combustion Air Systems 13
1.12 Gross Natural Draft 14
1.13 Acceptable Pressure Ranges 14
1.14 Exhaust Fans 14
1.15 Corrections for Altitude 14
1.16 Manifolded Systems 15
1.17 Elbow Quantity and Separation 15
1.18 Exhaust Muffler And Air Inlet Attenuator Guidelines 15
1.19 Vent and Combustion Air System Design Requirements 16
1.20 Condensate Removal 20
1.21 Individually Vented Systems 21
1.21.1 BMK 1500 Example: 22
1.22 Manifolded Ducted Combustion Air 23
1.23 Common Vent Breeching (Manifolded) 25
1.24 Pressure Drop and Draft Data Tables 27

1.1 General

The AERCO Benchmark gas-fired boiler is a high efficiency, forced draft, hydronic-heating unit with unique venting capabilities. All Benchmark venting options (which include horizontal and vertical discharges, direct vent, and manifolded vent breeching), typically exceed the capabilities of competing combustion equipment. These and other features enable Benchmark boilers to provide extremely high thermal efficiencies and optimum temperature control under widely varying conditions. It is therefore critical that the flue gas vent and combustion air system be designed to maintain these objectives.

Benchmark's high efficiency is achieved through air/fuel modulation and the release of energy from the moisture condensing in the combustion products. Because condensation can occur in the exhaust vent system, means must be provided to remove the moisture accumulation. Each Benchmark model is fitted with a condensate removal trap, as indicated in Figures 1a – 1d, which illustrate the air inlet, vent connections and condensate removal connections for the BMK 750 (0.75 MMBTU), BMK 1000 (1.0 MMBTU), BMK 1500 (1.5 MMBTU), BMK 2000 (2.0 MMBTU), BMK 2500 (2.5 MMBTU), BMK 3000 (3.0 MMBTU) and BMK 6000 (6.0 MMBTU) models.

The design guidelines in this bulletin provide broad latitude while meeting the objectives of safety, longevity and optimum performance.

1.2 Materials and Approvals

The Benchmark boiler is a Category II, III, and IV appliance that requires special attention to exhaust venting and combustion air details. The exhaust vent MUST be UL listed for use with Category II, III, and IV appliances. The BMK 2500 and BMK 3000 can be used with polypropylene venting materials, but NOT PVC or CPVC. The smaller size BMK 750 and BMK 1000 boilers can be used with AL29-4C, VP1738A polypropylene, PVC or CPVC vent materials, due to their lower exhaust operating temperatures. If needed, a PVC Vent Adapter is provided in the Spares Kit included with each BMK 750 and BMK 1000 boiler. The BMK 6000 must use UL-listed vents made of AL29-4C stainless steel. Proper clearances to combustibles must be maintained per UL and the vent manufacturer requirements.

The UL, National Fuel Gas Code (ANSI Z223.1/ NFPA54)[1] and CSA B149.1-10 guidelines are often the basis for state and local codes. AERCO's recommendations follow the guidelines of these agencies, unless more stringent codes govern the installation site. The venting and combustion air systems must meet all applicable code requirements.

All Canada installations must comply with CSA B149.1 installation code.

1.3 Code Required Vent Terminations

The guidelines provided in this bulletin should be followed to comply with AERCO, UL, NFPA 54 (National Fuel Gas Code, ANSI Z223.1) and in Canada: CSA B149.1-10 recommendations and regulations.

Vent terminations should be at least 4 feet below, 1 foot above or 4 feet removed horizontally from any window, door or gravity air inlet of a building. Such terminations should extend beyond the outside face of the wall by at least 6 inches.

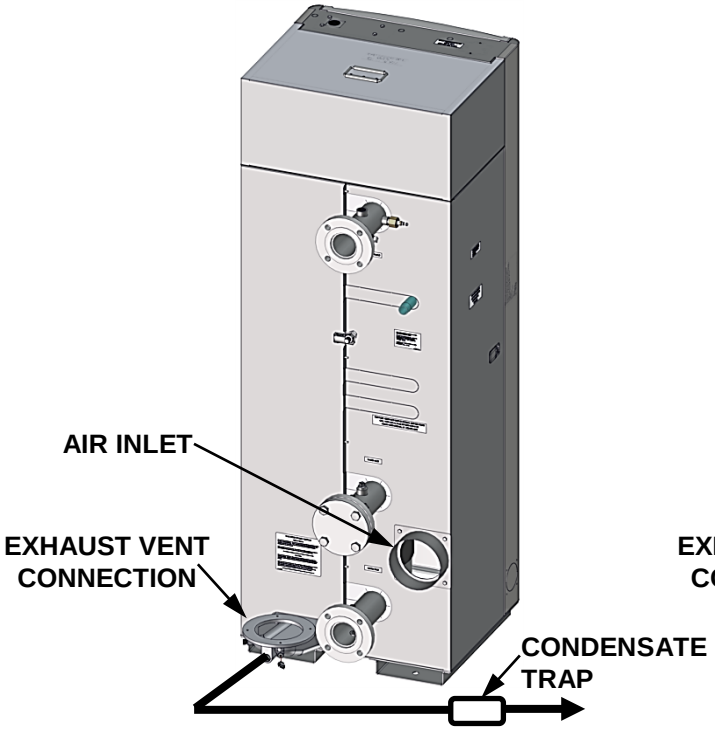


*Figure 1a: **BMK 750/1000***

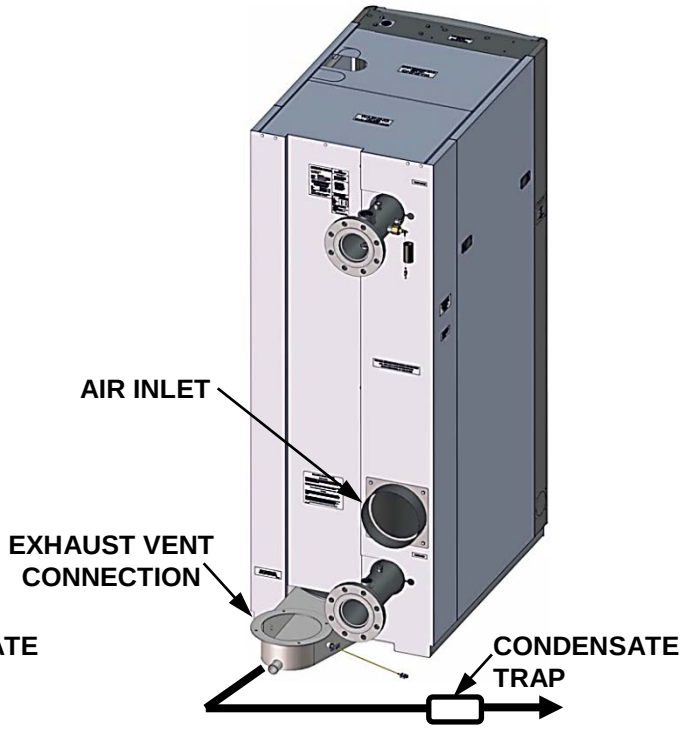


*Figure 1b: **BMK 1500/2000***

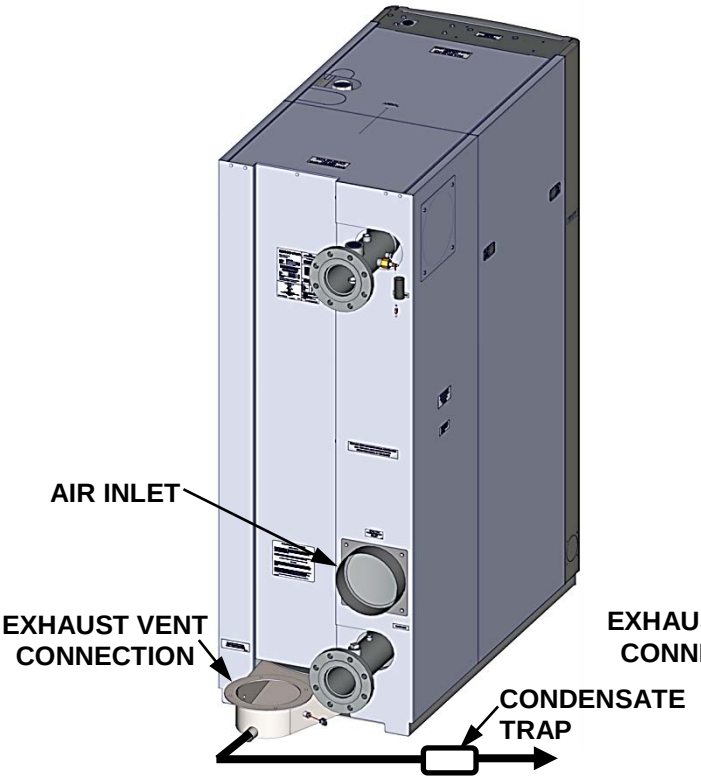


*Figure 1c: **BMK 2500/3000***

*Figure 1d: **BMK 6000***

The bottom of the vent termination should be at least 12 inches above both finished grade and any maximum snow accumulation level to avoid blocking the vent or air intake. The vent termination should be least 3 feet above any forced-air building inlet within 10 feet. Design must prevent flue gases from recirculating through the boiler air intake.

Vents should not terminate over public walkways or areas where condensate or vapor could create a nuisance or be detrimental to the operation of regulators, meters or related equipment.

Discharges should not be located in high wind, wind-blocked areas or corners, or be located directly behind vegetation. Discharges in these locations may cause the flue pressures to fluctuate and result in flame instability. As a general rule, designs should minimize wind effects.

Wall and roof penetrations should follow all applicable codes and the vent manufacturer's instructions. Vents should never be installed at less than required clearances to combustible materials, as enumerated in UL, NFPA, CSA B149.1-10 or local codes "Double-wall" or 'Thimble" assemblies are required when vents penetrate combustible walls or roofs.

Vertical discharges should extend at least 3 feet above the roof through properly flashed penetrations, and at least 2 feet above any object within a 10-foot horizontal distance.

Vertical and horizontal discharges should be designed to prevent rain from entering the vent. Large-mesh screens can be applied to protect against the entry of foreign objects but the 'free area' should be at least twice the flue cross-sectional area.

If the vent system is to be connected to an existing stack, the stack must be UL listed for Category II, III, and IV appliances (capable of 480°F, positive pressure and condensing flue gas operation). Masonry stacks must be lined, and the vent penetration must terminate flush with, and be sealed to, this liner. Vents may enter the stack through the bottom or side. All side connections must enter at a 45-degree connection in the direction of flow and must enter at different elevations, with the smallest vent connection at the highest elevation. Benchmark vents must not be connected to other manufacturer’s equipment.

The exhaust vent must be pitched upward toward the termination by a minimum of ¼ inch per foot of length. Condensate must flow back to the Benchmark unit freely, without accumulating in the vent.

1.4 Combustion Air Supply

The Benchmark boilers require the following combustion air volumes when operated at full capacity.

- BMK 750 165 SCFM
- BMK 1000 200 SCFM
- BMK 1500 325 SCFM
- BMK 2000 500 SCFM
- BMK 2500 600 SCFM
- BMK 3000 700 SCFM
- BMK 6000 1400 SCFM

These flows MUST be accommodated. Air supply is a direct requirement of NFPA, CSA B149.1-10 (Canada) and local codes that should be consulted for correct design implementation.

In equipment rooms containing other air-consuming equipment — including air compressors

and other combustion equipment — the combustion air supply system must be designed to accommodate all such equipment when all are operating simultaneously at maximum capacity.

Combustion air intakes must be located in areas that will not induce excessive (>0.10" water column (W.C.)) intake air pressure fluctuations. Designs should take into account equipment blowers and exhausts when using room air for combustion.

Intakes should be located to prevent infiltration of chlorides, halogens or any other chemicals that would be detrimental to the operation of combustion equipment. Common sources of these compounds are swimming pools, degreasing compounds, salts, plastic processing and refrigerants. When the environment contains these types of chemicals, the air MUST be supplied from the outdoors using direct-vent/ducted-combustion ductwork.

Air intakes must not be located in the proximity of garages, industrial and medical hood venting, loading docks or refrigerant vent lines. Boilers should not be installed in the proximity of activities that generate dust if that dust can enter the boiler intake. Boilers should be located to prevent moisture and precipitation from entering combustion air inlets.

When a boiler is used, temporarily, to provide heat during ongoing building construction or renovation, accumulated drywall dust, sawdust and similar particles can:

Accumulate in the unit's combustion air intake and block combustion air flow

Accumulate over the burner surface and restrict flow of air/fuel mixture

In these situations, AERCO recommends that a disposable air intake filter be installed, temporarily, above the boiler combustion air inlet. Air filters may be required year-round in instances in which dust or debris can enter the combustion air tube. Consult the boiler Operations and Maintenance Manual for details.

Combustion air temperatures as low as -30°F can be used without affecting the integrity of the equipment; however, the combustion settings may require adjustment to compensate for site conditions.

1.5 Combustion Air from WITHIN the Building

Where combustion air will originate from within the building, air must be provided to the equipment room from two permanent openings to an interior room (or rooms). Openings connecting indoor spaces shall be sized and located in accordance with the following:

- Each opening shall have a minimum free area of 1 inch^2 per 1,000 BTU/hr (2,200 mm^2/kW) of total input rating of all appliances in the space, but not less than 100 inch^2 (0.06 m^2).
- One opening shall commence within 12 inches (300 mm) of the top of the enclosure, and one opening shall commence within 12 inches (300 mm) of the bottom. (See Figure 2).
- The minimum dimension of air openings shall be not less than 3 inches (80 mm).

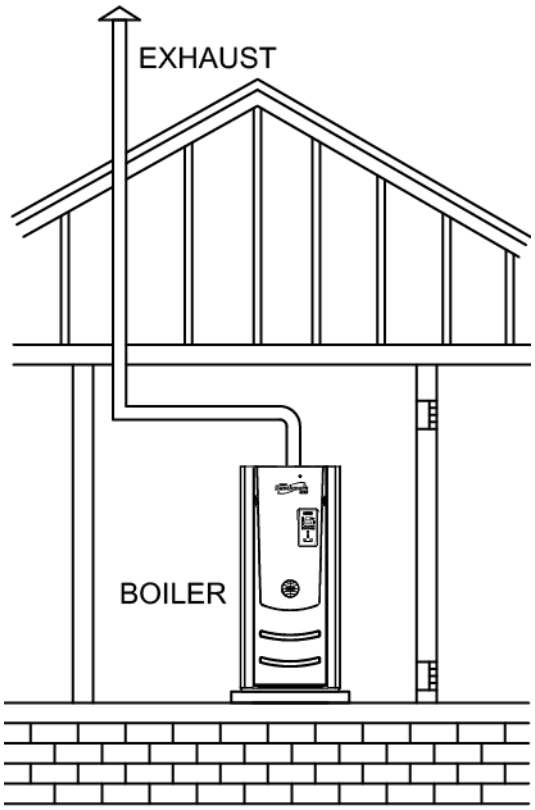


Figure 2: All Combustion Air from Adjacent Indoor Spaces through Indoor Combustion Air Openings

1.6 Combustion Air from OUTSIDE the Building

Outdoor combustion air shall be provided through opening(s) to the outdoors in accordance with the methods described below. The minimum dimension of air openings shall not be less than 3 inches (80 mm). The required size of the openings for combustion air shall be based upon the net free area of each opening. When the free area through a louver, grille, or screen is known, it shall be used to calculate the opening size required to provide the free area specified. For additional details, consult NFPA 54, or in Canada, CSA B149.1-10, paragraphs 8.4.1 and 8.4.3.

1.7 Two-Permanent-Openings Method (USA Only)

Two permanent openings shall be provided; one commencing within 12 inches (300 mm) of the top of the enclosure and one commencing within 12 inches (300 mm) of the bottom. The openings shall communicate directly — or by ducts — with the outdoors, or spaces that freely communicate with the outdoors, as show on the following pages:

1. When communicating directly with the outdoors, or when communicating to the outdoors through vertical ducts, each opening shall have a minimum free area of 1 $inch^2$ per 4,000 BTU/hr (550 mm^2/kW) of total input rating of all appliances in the space (see Figures 3 and 4).

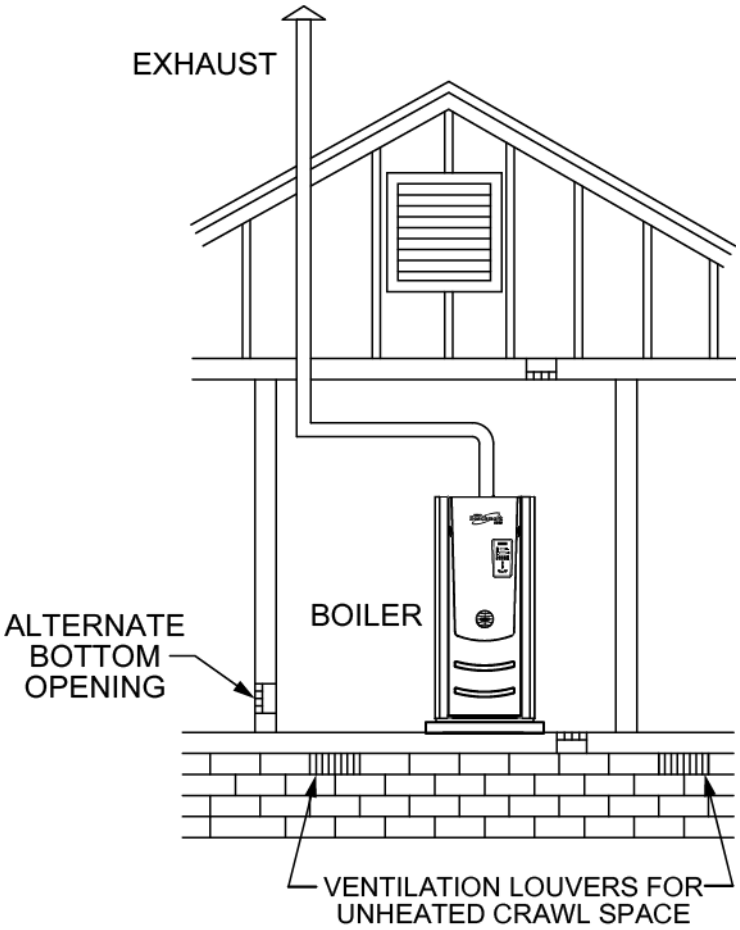


Figure 3: All Combustion Air From Outdoors - Inlet Air From Ventilated Crawl Space and Outlet Air to Ventilated Attic

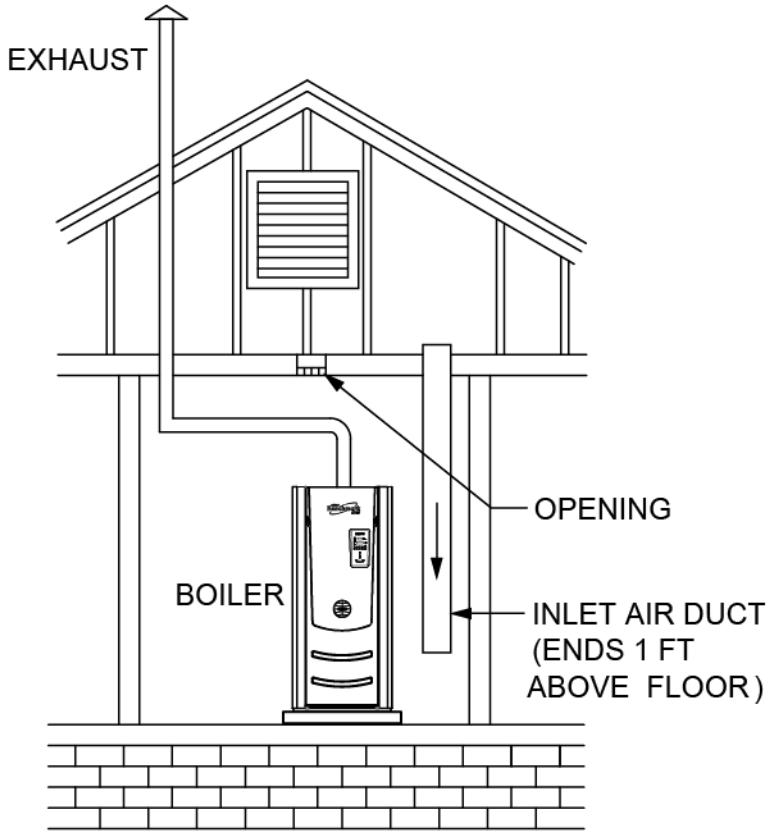


Figure 4: All Combustion Air from Outdoors - Through Ventilated Attic

2. When communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of 1 inch^2 per 2,000 BTU/hr. (1100 mm^2/kW) of total input rating of all appliances in the space (see Figure 5).

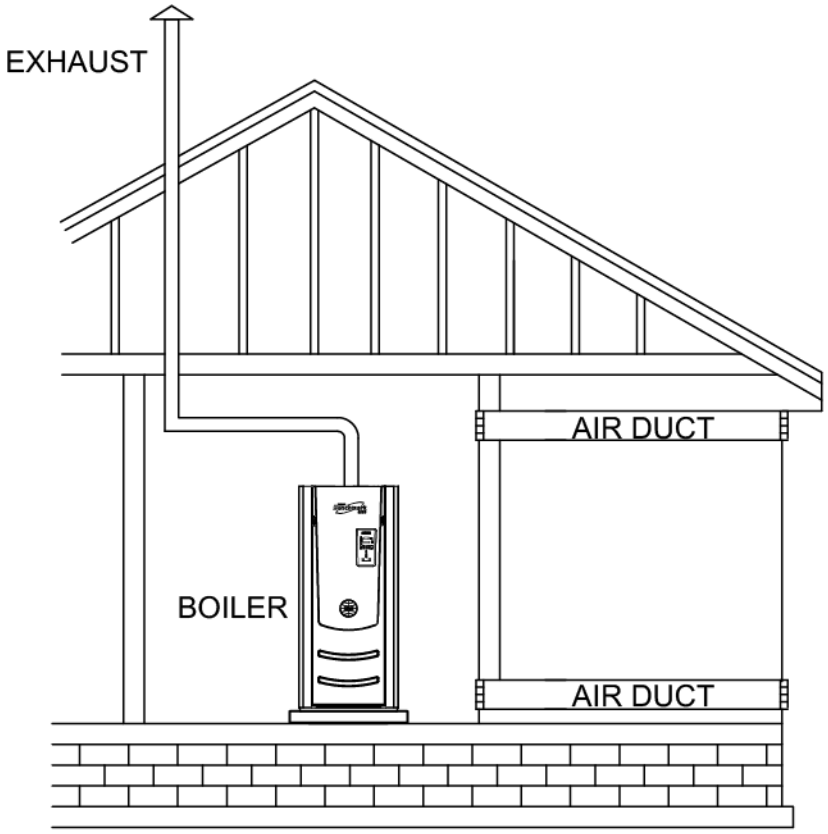


Figure 5: All Combustion Air from Outdoors Through Horizontal Ducts

1.8 One Permanent Opening Method

One permanent opening shall be provided, commencing within 12 inches (300 mm) of the top of the enclosure. The appliance shall have clearances of at least 1 inches (25 mm) from the sides and back of the appliance, and a clearance of 6 inches (150 mm) from the front. The opening shall communicate with the outdoors directly or through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors (as shown in Figure 6) and shall have a minimum free area as follows:

- 1 inch^2 per 3,000 BTU/hr (700 mm^2/kW) of the total input rating of all appliances located in the space.

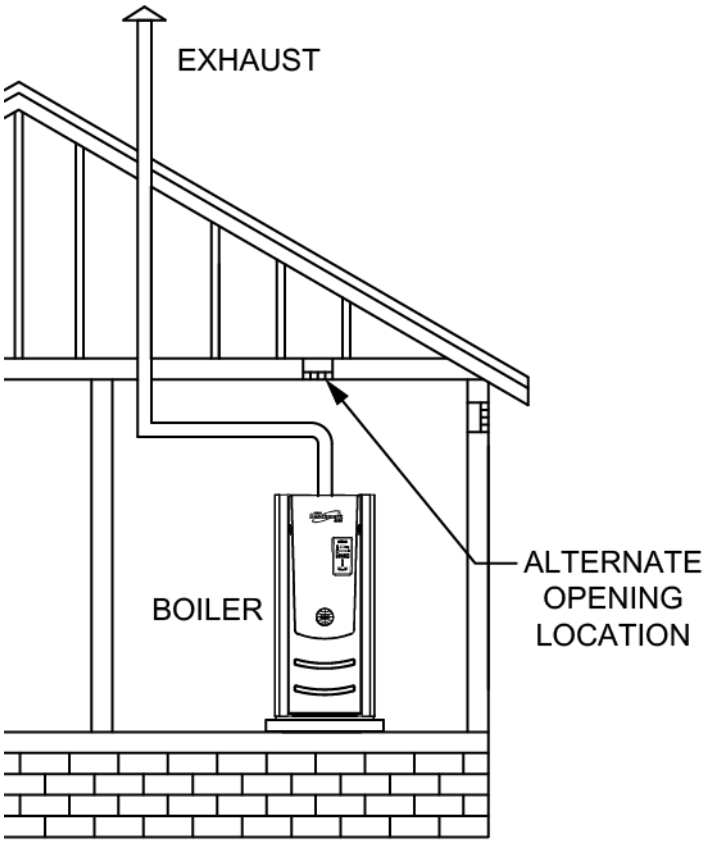


Figure 6: All Combustion Air from Outdoors Through Single Combustion Air Opening

1.9 Opening a Louver Through the Benchmark Boiler

A louver can be opened using the auxiliary relay contacts of the Benchmark boiler. These contacts are provided by a single pole double throw (SPDT) relay that is energized when there is a demand for heat and is de-energized after that demand is satisfied. The relay contacts are rated for 120 VAC at 5 amps, resistive.

NOTE

Do NOT power the louver directly using the Auxiliary Relay. An external relay (supplied by others) must be employed for this purpose. The boiler power cannot support external accessories.

If the louver features a proof-of-open switch, it can be connected to the boiler's delayed interlock. The delayed interlock must be closed for the unit to fire. If the louver requires time to open, a time-delay can be programmed to hold the start sequence of the boiler long enough for the proof-of-open switch to make (Parameter: Aux Start On Delay — programmable from 0 to 120 seconds). If the proof-of-open switch does not prove within the programmed time frame, the boiler will shut down.

For wiring connections and further details regarding the auxiliary relay, delayed interlock and the Aux Start On Delay parameter, refer to the Benchmark boiler's Operations and Maintenance manual.

If an AERCO Boiler Management System II (BMS II) is being used to manage a multiple boiler installation, the louver can be opened using the System Start Relay of the BMS II. Refer to the BMS II Operations and Maintenance Manual, GF-124, for wiring connections and further details.

1.10 Direct Vent/Ducted Combustion Air

The Benchmark is approved for direct vent installation; i.e., it can draw all combustion air from the outdoors through a metal or PVC duct connected between the Benchmark unit(s) and the outdoors. This configuration is useful for situations in which room air is insufficient or otherwise unsuitable for combustion. The minimum ducted combustion-air duct sizes for the Benchmark boilers are as follows:

- BMK 750 = 6-inch diameter
- BMK 1000 = 6-inch diameter
- BMK 1500 = 6-inch diameter
- BMK 2000 = 8-inch diameter
- BMK 2500 = 8-inch diameter
- BMK 3000 = 8-inch diameter
- BMK 6000 = 14-inch diameter

In many installations, the combustion air duct can be manifolded for multiple unit applications.

If the system is designed around common air intake it cannot be common exhaust.

The length and restriction of the ducted combustion duct directly impact the size, length and restriction of the discharge venting. The direct vent air intake should be located at least 3 feet below any vent termination within 10 feet.

A screen with mesh size not smaller than 1" x 1" must be installed at the inlet of the ducted combustion air duct.

IMPORTANT!

COMMON BREECHING OF AIR INTAKES CAN NOT BE COMBINED WITH COMMON BREECHING OF EXHAUSTS.

1.11 Exhaust Vent and Combustion Air Systems

The Benchmark supports several venting and combustion air options, and although the application parameters vary, there are basic similarities among all systems. Tables 1 through 5 at the end of this Guide address the pressure drop of most applicable vent and duct fittings and sizes. The losses in the vent exit and air duct entrance are also included.

It should be noted that flow and vent or duct diameter have the most significant effects on overall system pressure drop. When using fittings or terminations not listed in Tables 1, 2 and 3, consult the device manufacturer for actual pressure drop values. If rectangular duct is to be used, consult Table 5 for a round diameter duct size that has the identical pressure drop per length of rectangular duct.

The pressure drop values in Table 1b and 1c are in equivalent feet of 8-inch diameter exhaust vent. Note that 1 equivalent foot of 8-inch diameter vent is equal to 0.00546-inch W.C.

The pressure drop values used in Table 1a are in equivalent feet of 6-inch diameter exhaust vent. Note that 1 equivalent foot of 6-inch diameter vent is equal to 0.00581-inch W.C.

1.12 Gross Natural Draft

Flue gases have a lower density (and are lighter) than air and will rise, creating "gross natural draft." Gross natural draft is created when flue gases exit the vent at an elevation above the Benchmark boiler. The amount of draft depends upon the height of the stack and the difference between the flue gas temperature and the surrounding air temperatures (densities). Gross natural draft values for stacks at various heights above the Benchmark unit are presented in Table 3, Part 1 and Part 2. These draft values are based on an installation site at sea level.

Adding the gross natural draft (negative) to the vent and air system pressure drop (positive) determines if the total system will be positive pressure or negative pressure ("net natural draft"). As with most combustion equipment, negative pressure (net natural draft) systems should be treated differently from positive pressure systems when the discharge vents are manifolded. Note that sidewall vent terminations, as well as some vertical terminations, are positive pressure systems.

Contact your AERCO sales representative or AERCO International for design assistance and approval when designing manifolded exhaust vent systems.

CAUTION!

Do NOT install a non-sealed draft control damper.

1.13 Acceptable Pressure Ranges

For individually vented units, the exhaust system must be designed so that pressure measured at every point is in the range from -0.25” W.C. to +0.81” W.C. For common vented units, the exhaust system must be designed so that pressure measured at every point is in the range from -0.25” W.C. to +0.25” W.C. Pressures below -0.25” W.C. (more negative) may cause flame instability. Pressures above +0.25” W.C. for common vented units, or +0.81 W.C. for individually vented units (more positive), will prevent flue gases from exiting.

1.14 Exhaust Fans

If the Benchmark boiler’s exhaust system incorporates an exhaust fan, the system designer must size the vent pipe diameters, select the fan and determine the location of the fan sensor to maintain a -0.25” to +0.25” W.C. pressure range at the outlet of each boiler. Also, the designer must ensure that the exhaust fan material is acceptable for use with Category IV appliances.

1.15 Corrections for Altitude

Table 4 lists correction factors for installation altitudes above sea level. These factors must be applied to both the natural draft and pressure drops of vent and air ducts. *The pressure drop through vents and combustion air ducts will increase at higher elevations, while the natural draft will decrease.*

IMPORTANT!

MANIFOLDED SYSTEMS CANNOT BE USED FOR BOTH COMMON BREECHING OF AIR INTAKES AND EXHAUST VENTS.. ONLY ONE TYPE OF COMMON BREECHING (AIR INTAKE OR EXHAUST) CAN BE USED; BUT NOT BOTH.

1.16 Manifolded Systems

In many instances it may be practical to connect multiple units using a manifolded vent or exhaust configuration. However, when multiple units are connected by a manifolded air intake or exhaust vent, the operation of a given unit can be affected by the others, if the venting or combustion air system is not designed properly. Properly designed common vent and air supply systems can be installed that will prevent "operational interaction" between units.

Do not use static regain method on common ductwork, but rather, use one duct size for the common run (See Figure 13).

Contact your AERCO sales representative or AERCO International for design assistance and approval when designing manifolded exhaust vent systems.

1.17 Elbow Quantity and Separation

The quantity and angle of elbows and the distances between them can influence the system's exhaust and combustion air pressures, as well as its acoustical behavior. Designers should consider minimizing the quantity of elbows in the design and the use of angles less than 90°, whenever possible. Five or fewer elbows are recommended for individual venting/connections; five or fewer are recommended for common sections. **The minimum distance required between two elbows is five feet**.

1.18 Exhaust Muffler And Air Inlet Attenuator Guidelines

The Benchmark requires an exhaust muffler when it is installed in a noise-sensitive application and when the exhaust vent ducting is relatively short in length. The following criteria should be used to determine when to include a field-installed muffler in a Benchmark installation:

- The exhaust is **sidewall vented** and the vent is terminated in close proximity to residences, offices, hotel/hospital rooms, classrooms etc.

  OR

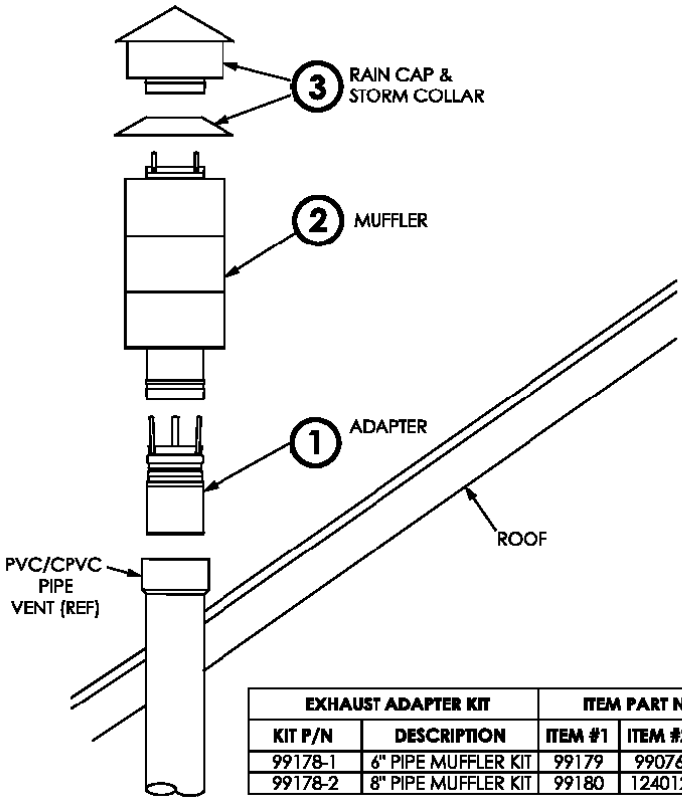
- The **total vertical section** of exhaust vent is **less than 25 linear feet** in length, and the vent terminates in close proximity to residences, offices, hotel/hospital rooms, classrooms etc.

For manifolded exhaust systems, the total vertical section includes only the common vertical; individual boiler vertical connectors are not included in the determination. For example, if the installation has a 20-foot common vertical, and each boiler has a 10-foot vertical connector, the total vertical section is only 20 feet. Because this length is less than 25 linear feet, a muffler is required.

For manifolded ducted combustion, the total vertical section includes only the common vertical; individual boiler vertical connectors are not included in the determination.

For example, if a manifolded ducted combustion has 20-foot common vertical, and each boiler has a 10-foot vertical connector, the total vertical section is only 20 feet. Because this is less than 25 linear feet, an attenuator is required.

An adapter kit is available for the BMK 750 and BMK 1000 units allowing the use of a muffler with PVC piping. When using PVC piping, it is necessary to install the muffler at the end of the vent piping, as shown in Figure 7. Part numbers for 6" and 8" kits are also shown in Figure 7.



EXHAUST ADAPTER KIT		ITEM PART NUMBER		
KIT P/N	DESCRIPTION	ITEM #1	ITEM #2	ITEM #3
99178-1	6" PIPE MUFFLER KIT	99179	99076	99181
99178-2	8" PIPE MUFFLER KIT	99180	124012	99182

Figure 7: Muffler Adapter Kits for BMK 750 & BMK 1000 Using PVC Pipe Exhaust Venting

Contact your local AERCO sales representative for more information on the AERCO exhaust muffler and air inlet attenuator.

1.19 Vent and Combustion Air System Design Requirements

The minimum exhaust vent and combustion air duct sizes for Benchmark Low NOx boilers models are as follows:

Benchmark Model	**Minimum Exhaust Vent & Combustion Air Duct Diameter**
BMK 750	6 inch dia.
BMK 1000	6 inch dia.
BMK 1500	6 inch dia.
BMK 2000	8 inch dia.
BMK 2500	8 inch dia.
BMK 3000	8 inch dia.
BMK 6000	14 inch dia.

A ¼-inch NPT combustion test hole is provided on each unit's exhaust manifold connection (See Figures 8a, 8b, 8c and 8d). A 24-inch length of straight vent is recommended downstream of the exhaust manifold, as illustrated in these figures.

The vent system should always be pitched up ¼ inch per foot of run towards the vent termination to enable condensate to drain back to the unit for disposal. Low spots in the vent must be avoided. Periodic inspection should be performed to assure correct drainage.

Benchmark vents should not be interconnected to those of other manufacturers' equipment.

Horizontal vent and ductwork should be supported to prevent sagging, in accordance with local code and the vent manufacturer's requirements. Vertical vent and ductwork should be supported to prevent excessive stress on the horizontal runs. The exhaust manifold and inlet air adapter should never be used as weight-supporting elements. The supports should be so arranged and the overall layout designed to assure that stresses on the vent and combustion air connections are minimized.

The vents and combustion air ducts may be insulated in accordance with the vent manufacturer's instructions and local codes.

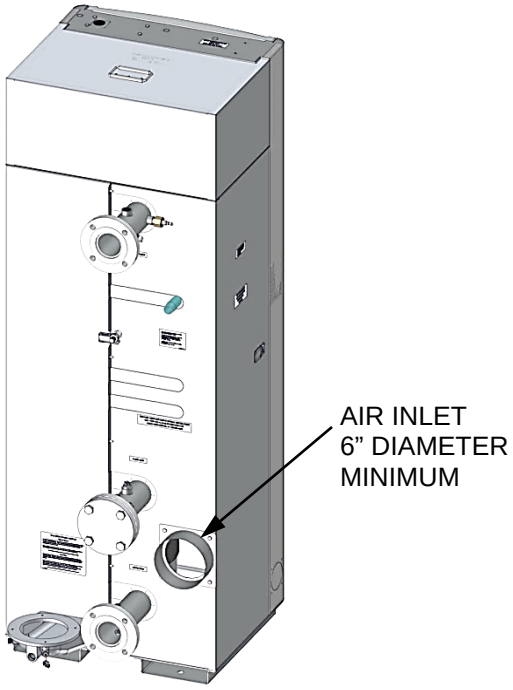


Figure 8a: Ducted Combustion Connection for BMK 750 & BMK 1000 Boilers

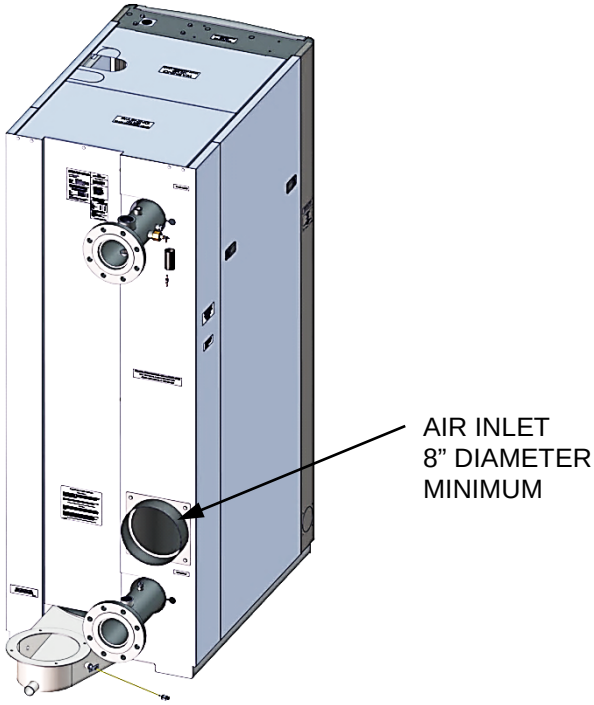


Figure 8b: Ducted Combustion Connection for BMK 1500 & BMK 2000 Boilers

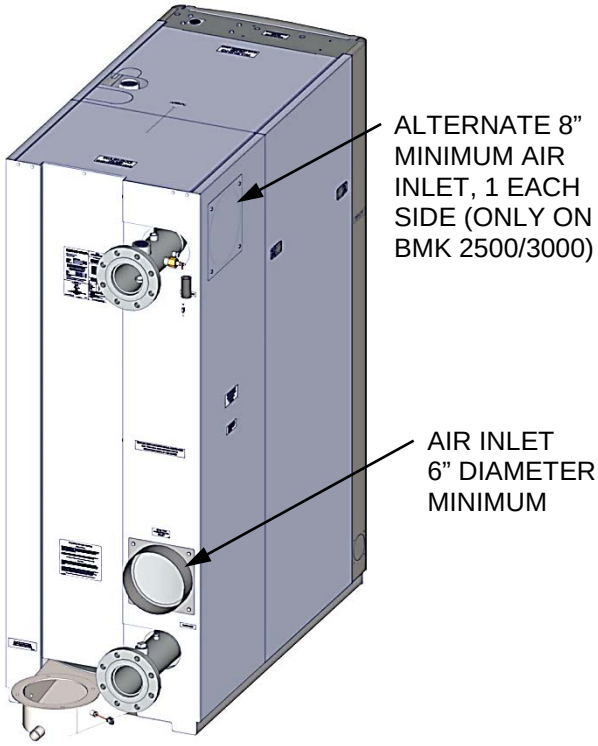


Figure 8c: Ducted Combustion Connection for a BMK 2500 & BMK 3000 Boiler

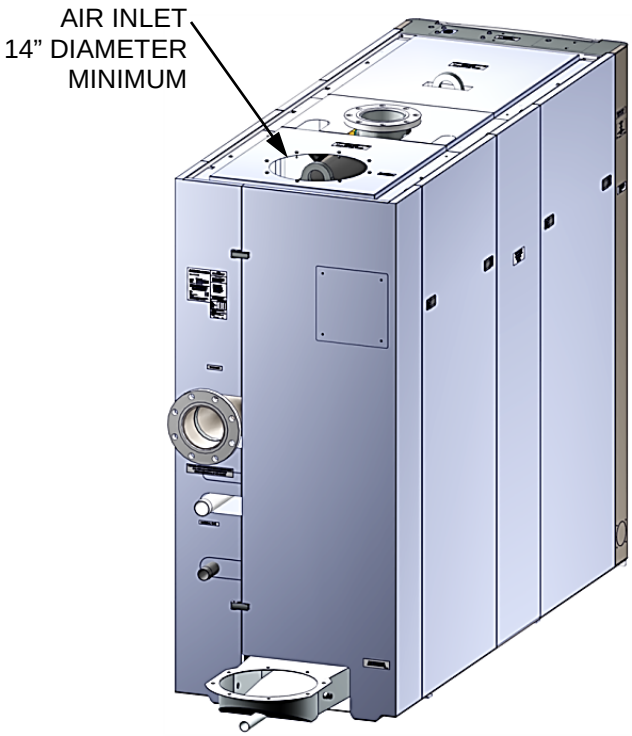


Figure 8d: Ducted Combustion Connection for a BMK 6000 Boiler

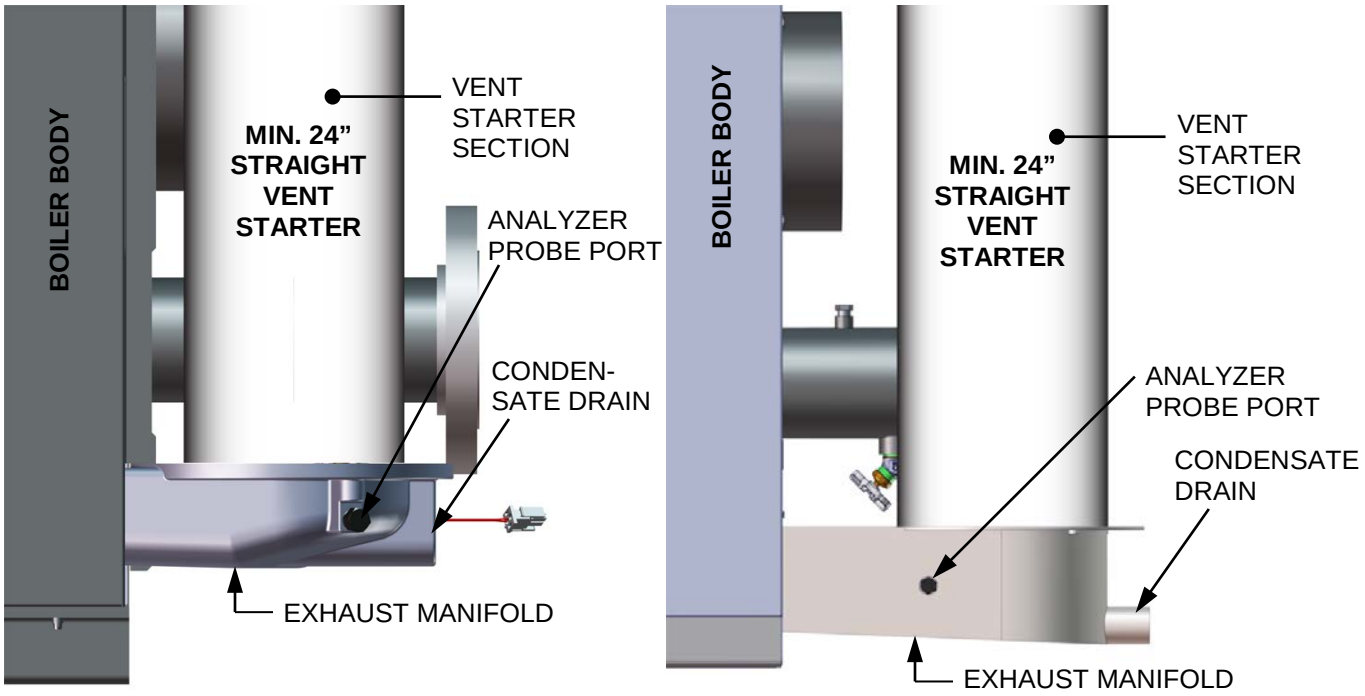


Figure 9a: Vent Starter Section – Left Side View

BMK 750 & BMK 1000 (Left) & BMK 1500 & BMK 2000 (Right)

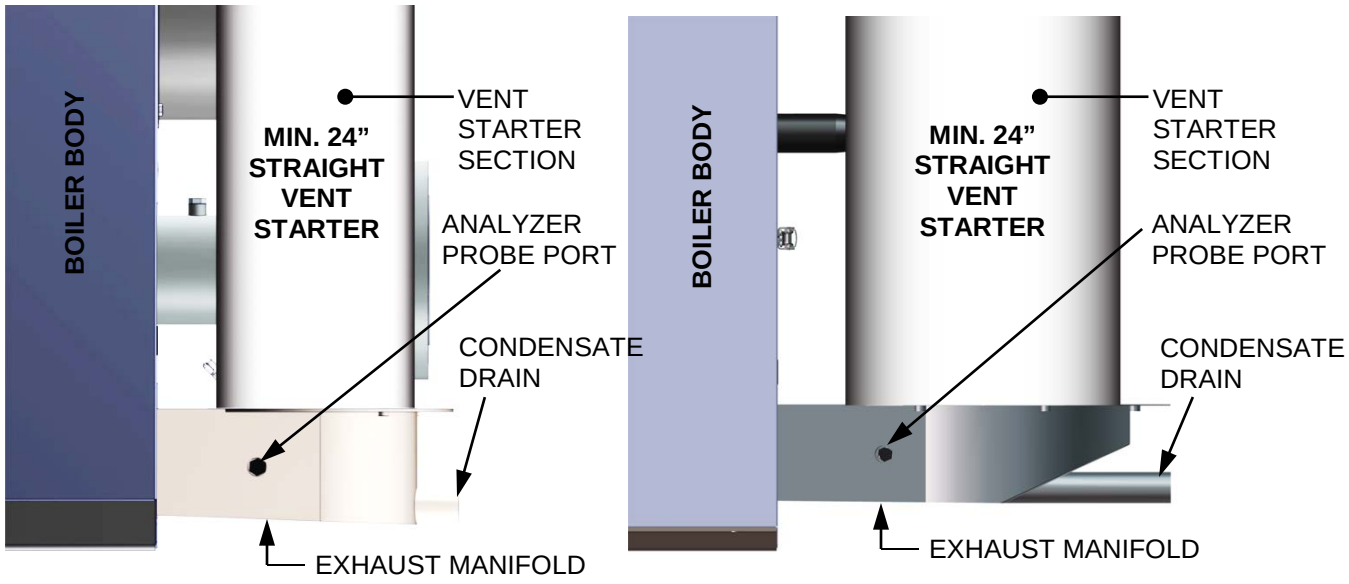


Figure 9b: Vent Starter Section – Left Side View

BMK 2500 & BMK 3000 (Left) & BMK 6000 (Right)

1.20 Condensate Removal

The exhaust vent system must be pitched back toward the Benchmark unit by a minimum of ¼-inch per foot of duct length to enable condensate to drain back to the unit for disposal. Low spots in the vent must be avoided to prevent the condensate from collecting.

The condensate trap assembly is located directly below the exhaust manifold. Plastic hose should be connected to the trap assembly and run to drain. Care should be taken to avoid hose kinks and to avoid raising the hose above the trap assembly. Condensate should flow freely to drain. The condensate-to-drain run must not be hard-piped so the trap can be removed periodically for maintenance purposes.

If the condensate must be lifted above the trap assembly to a drain, it should be drained into a sump. From there, a pump can lift the condensate away.

Each unit will produce the following approximate condensate quantities in the full condensing mode:

- BMK 750 = 6 gallons per hour
- BMK 1000 = 8 gallons per hour
- BMK 1500 = 9 gallons per hour
- BMK 2000 = 10 gallons per hour
- BMK 2500 = 15 gallons per hour
- BMK 3000 = 20 gallons per hour
- BMK 6000 = 40 gallons per hour

Condensate drain systems must be sized for full condensing mode.

In multiple boiler applications, it is common to manifold these drains together in a plastic pipe

manifold to a floor drain. Condensate manifolds must be large enough to handle the anticipated flow and must be properly secured and protected. Manifolds are generally located behind the boilers so that short runs of plastic tubing into the manifold can be used for the condensate drain. A base drain must be installed at the bottom of vertical common flue piping.

The pH level of the condensate produced by Benchmark boilers ranges between 3.0 and 3.2. The installation should be designed in accordance with local codes that specify acceptable pH limits. If required, any type of commercially available neutralizer may be used.

1.21 Individually Vented Systems

Systems with individual vents may be used with any of the combustion air systems described previously and illustrated in Figures 9a and 9b. The maximum combined pressure drop of the vent and combustion air system must not exceed 140 equivalent feet of length.

To calculate the pressure drop:

1) Calculate the exhaust vent pressure drop.
2) Calculate the combustion duct pressure drop.
3) Divide the vent pressure drop by the altitude correction factor (CF) listed in Table 4 to correct for installations above sea level.
4) Determine the natural draft, if any, from Table 3 and multiply it by the altitude CF.
5) Add the altitude corrected vent pressure drop (positive) and the draft (negative) to get the total vent pressure drop.
6) Add the total vent pressure drop to the altitude corrected combustion air duct pressure drop.

The total system pressure drop must not exceed 140 equivalent feet.

1.21.1 BMK 1500 Example:

Calculate the maximum pressure drop for a single boiler installation at 500 feet above sea level having a winter design temperature of 20°F. The duct system consists of:

1) An 6-inch diameter exhaust vent with three 90° elbows, two 45° elbows, 50 feet of horizontal run, 20 feet of vertical run
2) A rain cap termination
3) A 6-inch diameter ducted combustion air duct with two 90° elbows and 50 feet of run

CALCULATION:

6-inch Diameter Exhaust Vent Pressure

Two 90° elbows: 2 x 13.11 = 26.22 ft
One 45° elbow: 1 x 9.98= 9.98 ft
35 feet total run
(5 horizontal + 20 vertical):25 x 1.70 = 42.50 ft
Rain cap exit loss: 1 x 21.95 = 21.95 ft
Vent drop subtotal: = 100.65 ft
Altitude correction: $\frac{100.65}{0.982\ (CF)}$ = 102.49 ft
Natural draft for 20 feet @ 20°F outside temperature: = 12.6 ft
Altitude correction:-12.6 x 0.982 CF = -12.37 ft
Total vent drop: = 90.12 ft

6-inch Diameter Combustion Air Duct Pressure

Two 90° elbows: 2 x 5.84 = 11.68 ft
50 feet total run: 20 x 1.06 = 21.20 ft
Entrance loss: 1 x 8.60 = 8.60 ft

Combustion air drop subtotal: = 41.48 ft

Altitude correction: = $\frac{41.48}{0.982\ CF}$ = 42.24 ft
Combustion air drop total: = 42.24 ft

System total pressure drop

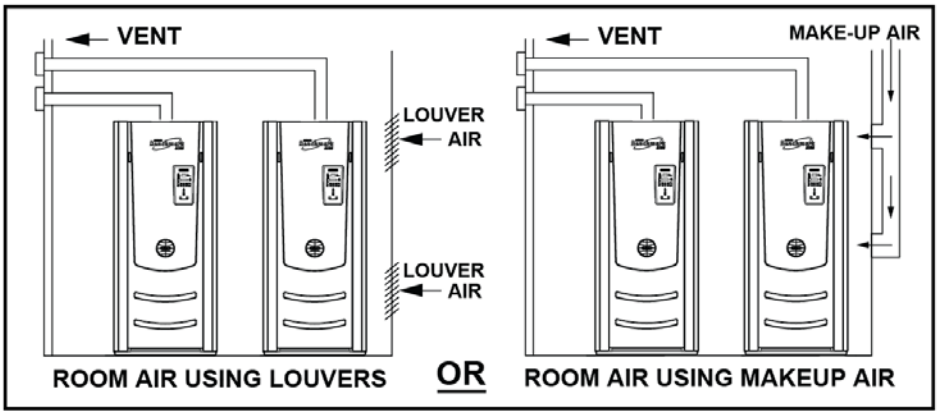
Vent drop + combustion air duct pressure drop
= 90.12 + 42.24
= 132.36 ft

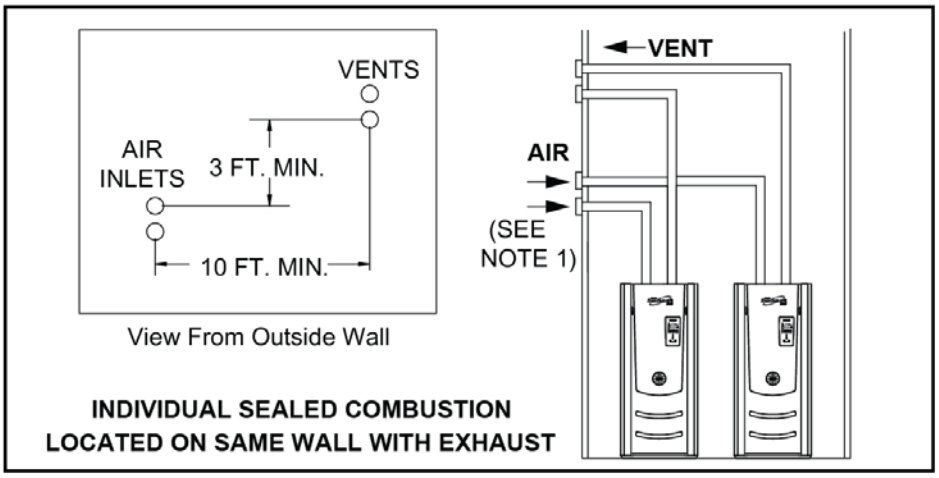
Conclusion:

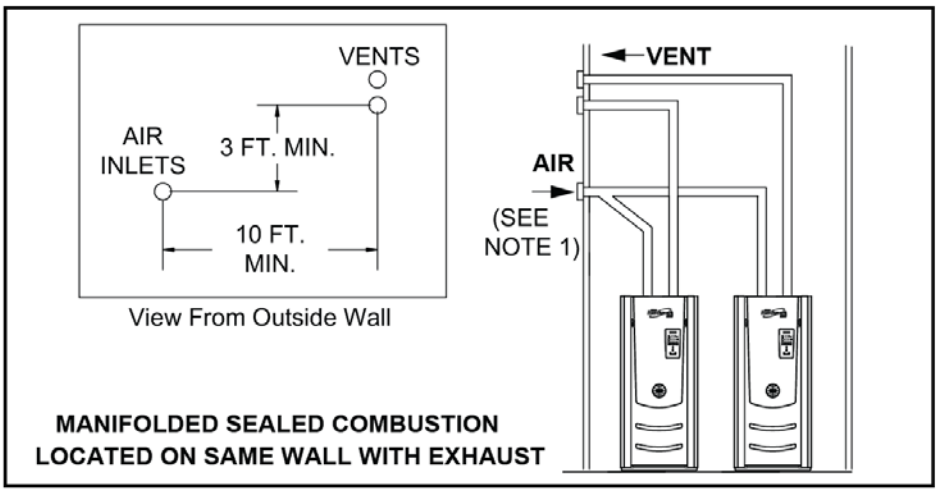
Pressure drop is less than 140 equivalent feet. System OK.

1.22 Manifolded Ducted Combustion Air

For systems using manifolded ducted combustion ductwork, use the longest length of common duct and the individual branch to the furthest boiler to calculate the pressure drop.



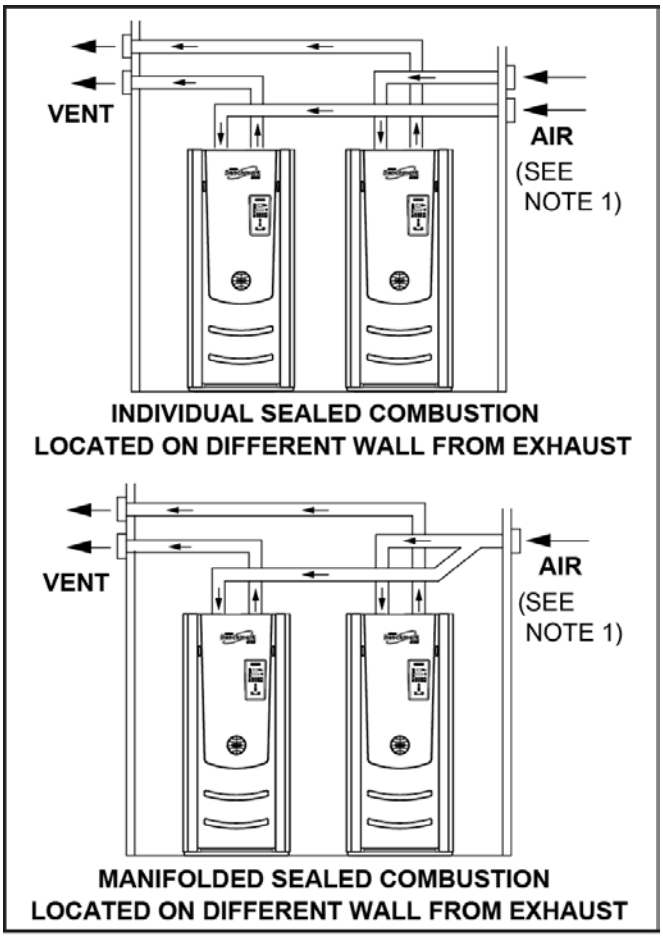




PREFERRED INSTALLATIONS

NOTE 1
For high wind, wind blocked sites, a tee may be installed at the fresh air inlet. The leg of the tee connects to the combustion air intake. The branches of the tee can be in the horizontal or vertical direction, as determined by the system designer and site conditions.

Figure 10a: Individual Vents – Preferred Installations



NOTE 1

For high wind, wind blocked sites, a tee may be installed at the fresh air inlet. The leg of the tee connects to the combustion air intake. The branches of the tee can be in the horizontal or vertical direction, as determined by the system designer and site conditions.

Figure 10b: Individual Vents – Acceptable Installations

1.23 Common Vent Breeching (Manifolded)

AERCO forced draft boilers are designed for application in common vent systems.

Contact your AERCO sales representative or AERCO International for design assistance and approval when designing manifolded exhaust vent systems.

Connections to common vent breeching or duct work must be accomplished with a 45° elbow in the direction of flow in the main breeching. "Tees" should not be used to accomplish these connections. See Figure 11a.

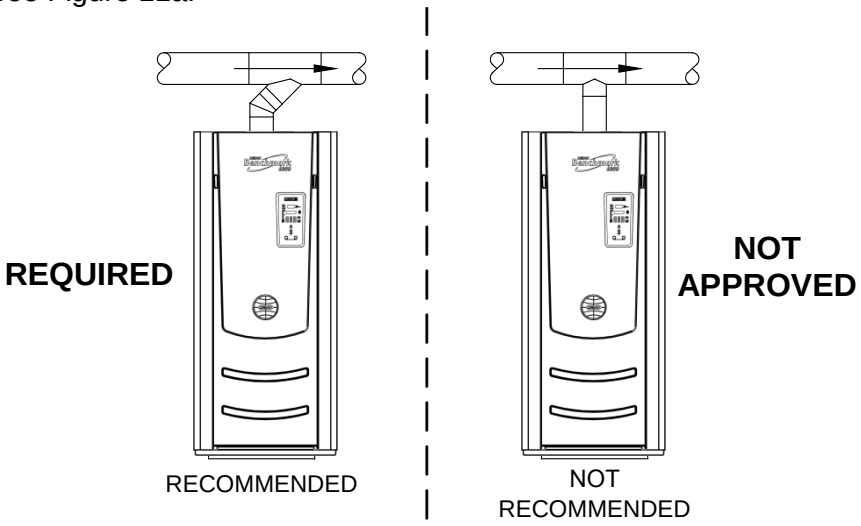


Figure 11a: Recommended Connections to Common Vent Breeching

Interconnection of groups of units must *never* be accomplished via a "tee". As shown in Figure 11b, change the direction with one of the mains and then connect the second three diameters (common section diameter) from this turn via a 45° connection.

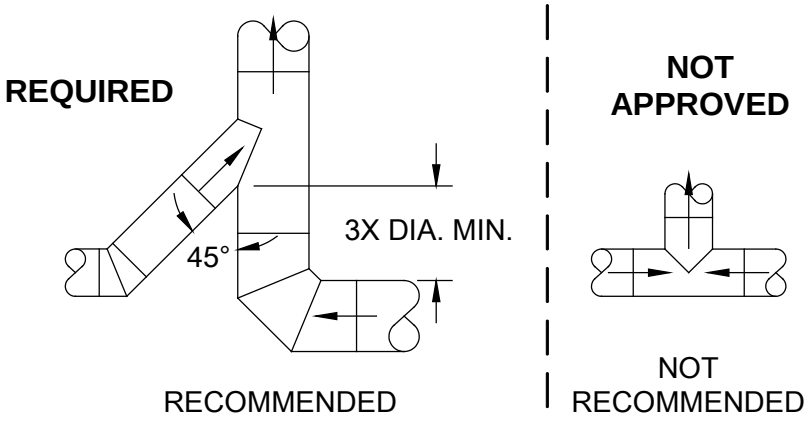


Figure 11b: Required Interconnection of Groups of Units

Figure 12 illustrates the preferable "transition vent section" when making the 45° connection into a main. The main can also remain at one diameter, as long as it is sized for the total number of units vented and the 45° branch connection is retained. Use of the recommended "transition" assembly will reduce the overall system pressure drop.

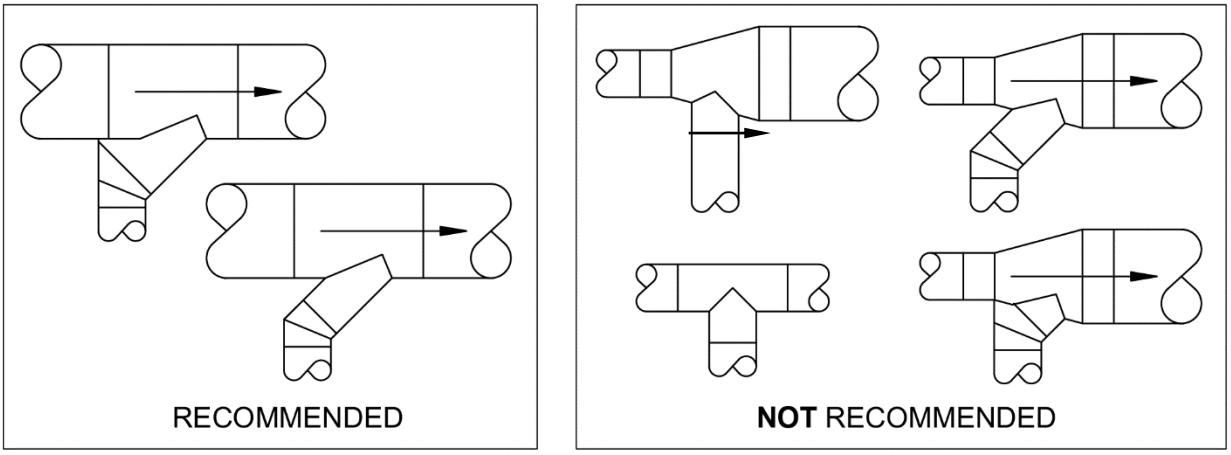


Figure 12: Required Transition Vent Sections

The vent system should always be pitched up ¼-inch per foot of run towards the vent termination (see Figure 13). This will enable condensate to drain back to the unit for disposal. Low spots in the vent must be avoided. Inspect periodically to ensure correct drainage.

As shown in Figure 13, the unit at the end of the vent main must be connected via an elbow. An end cap must not be used as it may cause vibration and flue pressure fluctuations.

As discussed previously, the static regain method should not be used for common ductwork, but rather, the one duct size should be used for the common run.

Benchmark vents should never be interconnected to those connected to other manufacturers' equipment.

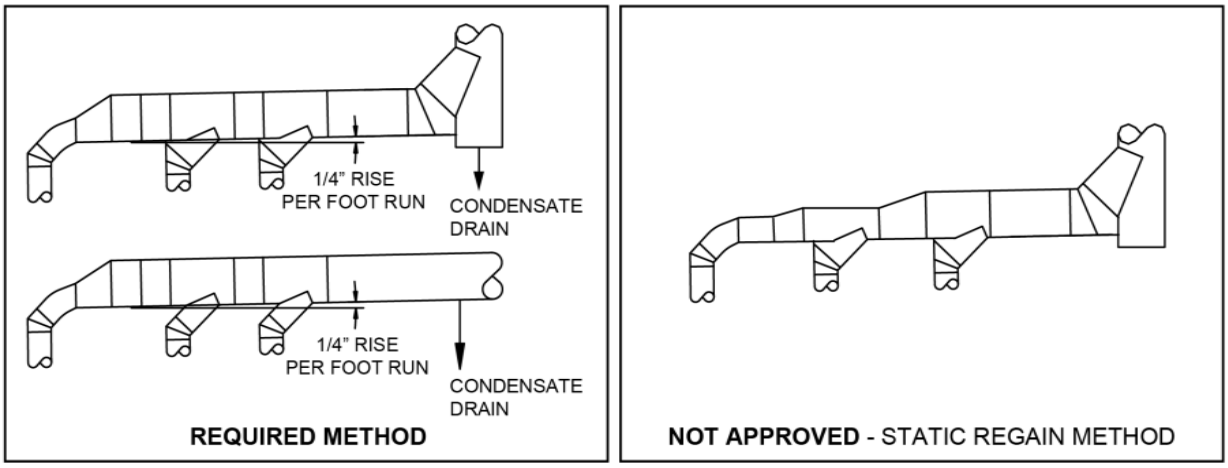


Figure 13: Connection of Unit at End of Vent Main

1.24 Pressure Drop and Draft Data Tables

Table 1a:
Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK 750 Boiler

(Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

Flue Vent (in. Dia.)	Flue Velocity (ft/sec)	Straight Run (eq. ft / foot)	90° elbow (eq. ft)	45° elbow (eq. ft)	Exit Loss Horiz. Term. (eq. ft)	Exit Loss Rain Cap (eq. ft)
6	16.65	0.45	2.90	2.15	3.59	5.13
8	9.37	0.11	0.74	0.56	1.14	2.11
10	5.99	0.04	0.26	0.20	0.47	0.86
12	4.16	0.02	0.11	0.09	0.22	0.42
14	3.06	0.01	0.06	0.04	0.12	0.23

Table 1b:
Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK 1000 Boiler

(Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

Flue Vent (in. Dia.)	Flue Velocity (ft/sec)	Straight Run (eq. ft / foot)	90° elbow (eq. ft)	45° elbow (eq. ft)	Exit Loss Horiz. Term. (eq. ft)	Exit Loss Rain Cap (eq. ft)
6	22.20	0.77	5.15	3.82	6.39	9.12
8	12.49	0.18	1.32	0.99	2.02	3.75
10	7.99	0.06	0.47	0.36	0.83	1.54
12	5.55	0.03	0.20	0.16	0.40	0.74
14	4.08	0.01	0.10	0.08	0.22	0.40

Table 1c:
Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK 1500 Boiler

(Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

Flue Vent (in. Dia.)	Flue Velocity (ft/sec)	Straight Run (eq. ft / foot)	90° elbow (eq. ft)	45° elbow (eq. ft)	Exit Loss Horiz. Term. (eq. ft)	Exit Loss Rain Cap (eq. ft)
6	34.43	1.77	13.11	9.98	15.37	21.95
8	19.37	0.40	3.13	2.36	4.86	9.03
10	12.40	0.13	1.06	0.80	1.99	3.70
12	8.62	0.05	0.46	0.35	0.96	1.78
14	6.33	0.03	0.24	0.19	0.52	0.96
16	4.85	0.01	0.14	0.11	0.30	0.56

Table 1d:
Discharge Venting Pressure Drop for Single BMK 2000 Boiler

(Assuming 180ºF Water Temperature and 20ºF Rise at Sea Level)

Flue Vent (in. Dia.)	Flue Velocity (ft/sec)	Straight Run (eq. ft / foot)	90° elbow (eq. ft)	45° elbow (eq. ft)	Exit Loss Horiz. Term. (eq. ft)	Exit Loss Rain Cap (eq. ft)
8	26.35	0.71	5.86	4.42	9.00	16.71
10	16.87	0.23	2.08	1.59	3.69	6.85
12	11.71	0.09	0.91	0.70	1.78	3.30
14	8.60	0.04	0.46	0.35	0.96	1.78
16	6.59	0.02	0.25	0.20	0.56	1.04
18	5.21	0.01	0.15	0.12	0.35	0.65

Table 1e:
Discharge Venting Pressure Drop for Single BMK 2500 Boiler

(Assuming 180ºF Water Temperature and 20ºF Rise at Sea Level)

Flue Vent (in. Dia.)	Flue Velocity (ft/sec)	Straight Run (eq. ft / foot)	90° elbow (eq. ft)	45° elbow (eq. ft)	Exit Loss Horiz. Term. (eq. ft)	Exit Loss Rain Cap (eq. ft)
8	25.62	0.93	5.54	4.17	8.51	15.89
10	16.49	0.30	1.97	1.51	3.48	6.47
12	11.39	0.12	0.86	0.67	1.68	3.12
14	8.37	0.06	0.43	0.34	0.91	1.68
16	6.40	0.03	0.24	0.19	0.53	0.99
18	5.06	0.02	0.14	0.11	0.33	0.62

Table 1f:
Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK 3000 Boiler

(Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

Flue Vent (in. Dia.)	Flue Velocity (ft/sec)	Straight Run (eq. ft / foot)	90° elbow (eq. ft)	45° elbow (eq. ft)	Exit Loss Horiz. Term. (eq. ft)	Exit Loss Rain Cap (eq. ft)
8	29.28	1.24	7.54	5.68	11.58	21.50
10	19.13	0.40	2.68	2.05	4.74	8.81
12	13.28	0.16	1.17	0.90	2.29	4.25
14	9.76	0.08	0.58	0.46	1.23	2.29
16	7.47	0.04	0.32	0.25	0.72	1.34
18	5.90	0.02	0.19	0.15	0.45	0.84

Table 1g:
Discharge Flue Vent Pressure Drop (Eq. Ft.) for Single BMK 6000 Boiler

(Assuming 180°F Water Temperature and 20°F Rise at Sea Level)

Flue Vent (in. Dia.)	Flue Velocity (ft/sec)	Straight Run (eq. ft / foot)	90° elbow (eq. ft)	45° elbow (eq. ft)	Exit Loss Horiz. Term. (eq. ft)	Exit Loss Rain Cap (eq. ft)
12	30.59	0.64	6.20	4.80	12.13	22.53
14	22.48	0.29	3.11	2.42	6.55	12.16
16	17.21	0.15	1.72	1.34	3.84	7.13
18	13.60	0.08	1.02	0.79	2.40	4.45
20	11.01	0.05	0.64	0.50	1.57	2.92

Table 2a:
Ducted Combustion Air Duct Pressure Drop (Eq. Ft.) for BMK 750 Boiler

		Outside Air Temperature (°F)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
6" Duct Single Boiler	Straight Run	0.27	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.34
	90° Elbow	1.18	1.23	1.29	1.38	1.47	1.57	1.68	1.79	1.91
	45° Elbow	0.87	0.91	0.96	1.02	1.09	1.16	1.24	1.32	1.41
	Ent. Loss	1.83	1.92	2.02	2.15	2.29	2.45	2.61	2.79	2.97
8" Duct Single Boiler	Straight Run	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
	90° Elbow	0.30	0.31	0.33	0.35	0.38	0.40	0.43	0.46	0.49
	45° Elbow	0.23	0.24	0.25	0.27	0.28	0.30	0.32	0.34	0.37
	Ent. Loss	0.58	0.61	0.64	0.68	0.73	0.77	0.83	0.88	0.94
8" Duct Two Boilers	Straight Run	0.20	0.21	0.22	0.23	0.25	0.26	0.28	0.30	0.32
	90° Elbow	1.20	1.26	1.32	1.41	1.50	1.60	1.71	1.83	1.95
	45° Elbow	0.90	0.95	1.00	1.06	1.13	1.21	1.29	1.38	1.47
	Ent. Loss	2.32	2.43	2.55	2.72	2.90	3.10	3.31	3.53	3.76
10" Duct Two Boilers	Straight Run	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.11
	90° Elbow	0.43	0.45	0.47	0.50	0.53	0.57	0.61	0.65	0.69
	45° Elbow	0.33	0.34	0.36	0.38	0.41	0.44	0.47	0.50	0.53
	Ent. Loss	0.95	1.00	1.05	1.11	1.19	1.27	1.35	1.44	1.54
10" Duct Three Boilers	Straight Run	0.14	0.15	0.15	0.16	0.17	0.19	0.20	0.21	0.23
	90° Elbow	0.96	1.01	1.06	1.13	1.20	1.28	1.37	1.46	1.56
	45° Elbow	0.74	0.77	0.81	0.86	0.92	0.98	1.05	1.12	1.19
	Ent. Loss	2.14	2.24	2.35	2.51	2.68	2.86	3.05	3.25	3.47
12" Duct Three Boilers	Straight Run	0.06	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09
	90° Elbow	0.42	0.44	0.46	0.49	0.53	0.56	0.60	0.64	0.68
	45° Elbow	0.32	0.34	0.36	0.38	0.41	0.43	0.46	0.49	0.53
	Ent. Loss	1.03	1.08	1.13	1.21	1.29	1.38	1.47	1.57	1.67
12" Duct Four Boilers	Straight Run	0.10	0.10	0.11	0.11	0.12	0.13	0.14	0.15	0.16
	90° Elbow	0.74	0.78	0.82	0.87	0.93	1.00	1.06	1.13	1.21
	45° Elbow	0.58	0.60	0.63	0.68	0.72	0.77	0.82	0.88	0.94
	Ent. Loss	1.83	1.92	2.02	2.15	2.29	2.45	2.61	2.79	2.97
14" Duct Four Boilers	Straight Run	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07
	90° Elbow	0.37	0.39	0.41	0.44	0.47	0.50	0.53	0.57	0.61
	45° Elbow	0.29	0.30	0.32	0.34	0.36	0.39	0.41	0.44	0.47
	Ent. Loss	0.99	1.04	1.09	1.16	1.24	1.32	1.41	1.50	1.60

NOTES: 1) Calculation assumes 300 scfm per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)
3) Units for "Elbows" and "Ent. Loss" are (equivalent feet / item)

Table 2b:
Ducted Combustion Air Duct Pressure Drop (Eq. Ft.) for BMK 1000 Boiler

		Outside Air Temperature (°F)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
6" Duct Single Boiler	Straight Run	0.46	0.47	0.48	0.50	0.51	0.53	0.54	0.56	0.58
	90° Elbow	2.09	2.19	2.30	2.45	2.62	2.79	2.98	3.18	3.39
	45° Elbow	1.55	1.62	1.70	1.82	1.94	2.07	2.21	2.35	2.51
	Ent. Loss	3.26	3.42	3.58	3.82	4.08	4.35	4.64	4.95	5.29
8" Duct Single Boiler	Straight Run	0.11	0.11	0.12	0.12	0.12	0.13	0.13	0.14	0.14
	90° Elbow	0.53	0.56	0.59	0.63	0.67	0.71	0.76	0.81	0.87
	45° Elbow	0.40	0.42	0.44	0.47	0.50	0.54	0.57	0.61	0.65
	Ent. Loss	1.03	1.08	1.13	1.21	1.29	1.38	1.47	1.57	1.67
8" Duct Two Boilers	Straight Run	0.34	0.36	0.37	0.40	0.42	0.45	0.48	0.51	0.55
	90° Elbow	2.13	2.24	2.35	2.51	2.67	2.85	3.04	3.25	3.47
	45° Elbow	1.61	1.69	1.77	1.89	2.02	2.15	2.29	2.45	2.61
	Ent. Loss	4.12	4.32	4.54	4.84	5.16	5.51	5.88	6.27	6.69
10" Duct Two Boilers	Straight Run	0.11	0.12	0.12	0.13	0.14	0.15	0.16	0.17	0.18
	90° Elbow	0.76	0.80	0.84	0.89	0.95	1.01	1.08	1.15	1.23
	45° Elbow	0.58	0.61	0.64	0.68	0.73	0.78	0.83	0.88	0.94
	Ent. Loss	1.69	1.77	1.86	1.98	2.11	2.26	2.41	2.57	2.74
10" Duct Three Boilers	Straight Run	0.24	0.25	0.26	0.28	0.30	0.32	0.34	0.36	0.38
	90° Elbow	1.71	1.79	1.88	2.00	2.14	2.28	2.43	2.60	2.77
	45° Elbow	1.31	1.37	1.44	1.53	1.64	1.75	1.86	1.99	2.12
	Ent. Loss	3.80	3.98	4.18	4.46	4.76	5.08	5.42	5.78	6.16
12" Duct Three Boilers	Straight Run	0.10	0.10	0.11	0.11	0.12	0.13	0.14	0.15	0.16
	90° Elbow	0.74	0.78	0.82	0.87	0.93	1.00	1.06	1.13	1.21
	45° Elbow	0.58	0.60	0.63	0.68	0.72	0.77	0.82	0.88	0.94
	Ent. Loss	1.83	1.92	2.02	2.15	2.29	2.45	2.61	2.79	2.97
12" Duct Four Boilers	Straight Run	0.16	0.17	0.18	0.19	0.21	0.22	0.23	0.25	0.26
	90° Elbow	1.32	1.39	1.46	1.56	1.66	1.77	1.89	2.02	2.15
	45° Elbow	1.02	1.08	1.13	1.20	1.28	1.37	1.46	1.56	1.66
	Ent. Loss	3.26	3.42	3.58	3.82	4.08	4.35	4.64	4.95	5.29
14" Duct Four Boilers	Straight Run	0.08	0.08	0.08	0.09	0.10	0.10	0.11	0.12	0.12
	90° Elbow	0.66	0.70	0.73	0.78	0.83	0.89	0.95	1.01	1.08
	45° Elbow	0.52	0.54	0.57	0.61	0.65	0.69	0.74	0.79	0.84
	Ent. Loss	1.76	1.84	1.93	2.06	2.20	2.35	2.51	2.67	2.85

NOTES:

1) Calculation assumes 300 scfm per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)
3) Units for "Elbows" and "Ent. Loss" are (equivalent feet / item)

Table 2c:
Ducted Combustion Air Duct Pressure Drop (Eq. Ft.) for BMK 1500 Boiler

		Outside Air Temperature (°F)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
6" Duct Single Boiler	Straight Run	0.98	1.00	1.02	1.06	1.09	1.13	1.16	1.20	1.24
	90° Elbow	4.97	5.21	5.47	5.84	6.23	6.64	7.09	7.56	8.07
	45° Elbow	3.78	3.97	4.17	4.44	4.74	5.06	5.40	5.76	6.14
	Ent. Loss	7.33	7.69	8.07	8.60	9.18	9.79	10.45	11.15	11.89
8" Duct Single Boiler	Straight Run	0.23	0.24	0.24	0.25	0.26	0.27	0.28	0.29	0.30
	90° Elbow	1.19	1.25	1.31	1.39	1.49	1.59	1.69	1.81	1.93
	45° Elbow	0.89	0.94	0.98	1.05	1.12	1.19	1.27	1.36	1.45
	Ent. Loss	2.32	2.43	2.55	2.72	2.90	3.10	3.31	3.53	3.76
10" Duct Two Boilers	Straight Run	0.24	0.25	0.26	0.28	0.30	0.32	0.34	0.36	0.38
	90° Elbow	1.60	1.68	1.77	1.88	2.01	2.14	2.29	2.44	2.60
	45° Elbow	1.21	1.27	1.33	1.42	1.51	1.61	1.72	1.84	1.96
	Ent. Loss	3.80	3.98	4.18	4.46	4.76	5.08	5.42	5.78	6.16
12" Duct Two Boilers	Straight Run	0.10	0.10	0.11	0.11	0.12	0.13	0.14	0.15	0.16
	90° Elbow	0.70	0.73	0.77	0.82	0.88	0.93	1.00	1.06	1.13
	45° Elbow	0.53	0.56	0.59	0.62	0.67	0.71	0.76	0.81	0.86
	Ent. Loss	1.83	1.92	2.02	2.15	2.29	2.45	2.61	2.79	2.97
12" Duct Three Boilers	Straight Run	0.20	0.21	0.22	0.24	0.26	0.27	0.29	0.31	0.33
	90° Elbow	1.57	1.65	1.73	1.85	1.97	2.10	2.24	2.39	2.55
	45° Elbow	1.20	1.26	1.32	1.41	1.50	1.60	1.71	1.82	1.94
	Ent. Loss	4.12	4.32	4.54	4.84	5.16	5.51	5.88	6.27	6.69
14" Duct Three Boilers	Straight Run	0.09	0.10	0.10	0.11	0.12	0.13	0.14	0.14	0.15
	90° Elbow	0.82	0.86	0.90	0.96	1.02	1.09	1.17	1.24	1.33
	45° Elbow	0.63	0.66	0.70	0.74	0.79	0.85	0.90	0.96	1.03
	Ent. Loss	2.22	2.33	2.45	2.61	2.79	2.97	3.17	3.38	3.61
14" Duct Four Boilers	Straight Run	0.16	0.17	0.18	0.19	0.20	0.22	0.23	0.25	0.26
	90° Elbow	1.45	1.53	1.60	1.71	1.82	1.94	2.07	2.21	2.36
	45° Elbow	1.12	1.18	1.24	1.32	1.41	1.50	1.60	1.71	1.83
	Ent. Loss	3.95	4.15	4.35	4.64	4.95	5.29	5.64	6.02	6.42
16" Duct Four Boilers	Straight Run	0.08	0.09	0.09	0.10	0.10	0.11	0.12	0.13	0.13
	90° Elbow	0.84	0.88	0.93	0.99	1.06	1.13	1.20	1.28	1.37
	45° Elbow	0.66	0.69	0.73	0.78	0.83	0.88	0.94	1.00	1.07
	Ent. Loss	2.32	2.43	2.55	2.72	2.90	3.10	3.31	3.53	3.76

NOTES: 1) Calculation assumes 300 scfm per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)
3) Units for "Elbows" and "Ent. Loss" are (equivalent feet / item)

Table 2d:
Ducted Combustion Air Duct Pressure Drop for BMK 2000 Boiler

		Outside Air Temperature (°F)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
8" Duct Single Boiler	Straight Run	0.40	0.41	0.42	0.43	0.44	0.46	0.47	0.49	0.50
	90° Elbow	2.13	2.24	2.35	2.51	2.67	2.85	3.04	3.25	3.47
	45° Elbow	1.61	1.69	1.77	1.89	2.02	2.15	2.29	2.45	2.61
	Ent. Loss	4.12	4.32	4.54	4.84	5.16	5.51	5.88	6.27	6.69
10" Duct Single Boiler	Straight Run	0.13	0.13	0.14	0.14	0.15	0.15	0.16	0.16	0.17
	90° Elbow	0.76	0.80	0.84	0.89	0.95	1.01	1.08	1.15	1.23
	45° Elbow	0.58	0.61	0.64	0.68	0.73	0.78	0.83	0.88	0.94
	Ent. Loss	1.69	1.77	1.86	1.98	2.11	2.26	2.41	2.57	2.74
12" Duct Two Boilers	Straight Run	0.16	0.17	0.18	0.19	0.21	0.22	0.23	0.25	0.26
	90° Elbow	1.32	1.39	1.46	1.56	1.66	1.77	1.89	2.02	2.15
	45° Elbow	1.02	1.08	1.13	1.20	1.28	1.37	1.46	1.56	1.66
	Ent. Loss	3.26	3.42	3.58	3.82	4.08	4.35	4.64	4.95	5.29
14" Duct Two Boilers	Straight Run	0.08	0.08	0.08	0.09	0.10	0.10	0.11	0.12	0.12
	90° Elbow	0.66	0.70	0.73	0.78	0.83	0.89	0.95	1.01	1.08
	45° Elbow	0.52	0.54	0.57	0.61	0.65	0.69	0.74	0.79	0.84
	Ent. Loss	1.76	1.84	1.93	2.06	2.20	2.35	2.51	2.67	2.85
16" Duct Three Boilers	Straight Run	0.08	0.09	0.09	0.10	0.10	0.11	0.12	0.13	0.13
	90° Elbow	0.82	0.86	0.91	0.97	1.03	1.10	1.18	1.25	1.34
	45° Elbow	0.64	0.67	0.71	0.76	0.81	0.86	0.92	0.98	1.04
	Ent. Loss	2.32	2.43	2.55	2.72	2.90	3.10	3.31	3.53	3.76
18" Duct Three Boilers	Straight Run	0.05	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.08
	90° Elbow	0.49	0.51	0.54	0.57	0.61	0.65	0.70	0.74	0.79
	45° Elbow	0.38	0.40	0.42	0.45	0.48	0.51	0.54	0.58	0.62
	Ent. Loss	1.45	1.52	1.59	1.70	1.81	1.93	2.06	2.20	2.35
18" Duct Four Boilers	Straight Run	0.08	0.08	0.09	0.09	0.10	0.11	0.11	0.12	0.13
	90° Elbow	0.87	0.91	0.96	1.02	1.09	1.16	1.24	1.32	1.41
	45° Elbow	0.68	0.71	0.75	0.80	0.85	0.91	0.97	1.03	1.10
	Ent. Loss	2.57	2.70	2.83	3.02	3.22	3.44	3.67	3.91	4.18
20" Duct Four Boilers	Straight Run	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08
	90° Elbow	0.55	0.57	0.60	0.64	0.68	0.73	0.78	0.83	0.88
	45° Elbow	0.43	0.45	0.47	0.50	0.53	0.57	0.61	0.65	0.69
	Ent. Loss	1.69	1.77	1.86	1.98	2.11	2.26	2.41	2.57	2.74

NOTES: 1) Calculation assumes 500 scfm per boiler at full fire rate.
2) Units for “Straight Run” pressure drop values are (eq. ft. / foot).
3) Units for “Elbows” and “Ent. Loss” are (equivalent feet / item).

Table 2e:
Ducted Combustion Air Duct Pressure Drop for BMK 2500 Boiler

		Outside Air Temperature (°F)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
8" Duct Single Boiler	Straight Run	0.40	0.41	0.42	0.43	0.44	0.46	0.47	0.49	0.50
	90° Elbow	2.13	2.24	2.35	2.51	2.67	2.85	3.04	3.25	3.47
	45° Elbow	1.61	1.69	1.77	1.89	2.02	2.15	2.29	2.45	2.61
	Ent. Loss	4.12	4.32	4.54	4.84	5.16	5.51	5.88	6.27	6.69
10" Duct Single Boiler	Straight Run	0.13	0.13	0.14	0.14	0.15	0.15	0.16	0.16	0.17
	90° Elbow	0.76	0.80	0.84	0.89	0.95	1.01	1.08	1.15	1.23
	45° Elbow	0.58	0.61	0.64	0.68	0.73	0.78	0.83	0.88	0.94
	Ent. Loss	1.69	1.77	1.86	1.98	2.11	2.26	2.41	2.57	2.74
12" Duct Two Boilers	Straight Run	0.16	0.17	0.18	0.19	0.21	0.22	0.23	0.25	0.26
	90° Elbow	1.32	1.39	1.46	1.56	1.66	1.77	1.89	2.02	2.15
	45° Elbow	1.02	1.08	1.13	1.20	1.28	1.37	1.46	1.56	1.66
	Ent. Loss	3.26	3.42	3.58	3.82	4.08	4.35	4.64	4.95	5.29
14" Duct Two Boilers	Straight Run	0.08	0.08	0.08	0.09	0.10	0.10	0.11	0.12	0.12
	90° Elbow	0.66	0.70	0.73	0.78	0.83	0.89	0.95	1.01	1.08
	45° Elbow	0.52	0.54	0.57	0.61	0.65	0.69	0.74	0.79	0.84
	Ent. Loss	1.76	1.84	1.93	2.06	2.20	2.35	2.51	2.67	2.85
16" Duct Three Boilers	Straight Run	0.08	0.09	0.09	0.10	0.10	0.11	0.12	0.13	0.13
	90° Elbow	0.82	0.86	0.91	0.97	1.03	1.10	1.18	1.25	1.34
	45° Elbow	0.64	0.67	0.71	0.76	0.81	0.86	0.92	0.98	1.04
	Ent. Loss	2.32	2.43	2.55	2.72	2.90	3.10	3.31	3.53	3.76
18" Duct Three Boilers	Straight Run	0.05	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.08
	90° Elbow	0.49	0.51	0.54	0.57	0.61	0.65	0.70	0.74	0.79
	45° Elbow	0.38	0.40	0.42	0.45	0.48	0.51	0.54	0.58	0.62
	Ent. Loss	1.45	1.52	1.59	1.70	1.81	1.93	2.06	2.20	2.35
18" Duct Four Boilers	Straight Run	0.08	0.08	0.09	0.09	0.10	0.11	0.11	0.12	0.13
	90° Elbow	0.87	0.91	0.96	1.02	1.09	1.16	1.24	1.32	1.41
	45° Elbow	0.68	0.71	0.75	0.80	0.85	0.91	0.97	1.03	1.10
	Ent. Loss	2.57	2.70	2.83	3.02	3.22	3.44	3.67	3.91	4.18
20" Duct Four Boilers	Straight Run	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.08
	90° Elbow	0.55	0.57	0.60	0.64	0.68	0.73	0.78	0.83	0.88
	45° Elbow	0.43	0.45	0.47	0.50	0.53	0.57	0.61	0.65	0.69
	Ent. Loss	1.69	1.77	1.86	1.98	2.11	2.26	2.41	2.57	2.74

NOTES: 1) Calculation assumes 700 scfm per boiler at full fire rate.

4) Units for “Straight Run” pressure drop values are (eq. ft. / foot).

5) Units for “Elbows” and “Ent. Loss” are (equivalent feet / item).

Table 2f:
Ducted Combustion Air Duct Pressure Drop (Eq. Ft.) for BMK 3000 MMBTU Boiler

		Outside Air Temperature (°F)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
8" Duct Single Boiler	Straight Run	0.85	0.87	0.89	0.91	0.94	0.97	1.00	1.03	1.06
	90° Elbow	4.75	4.98	5.23	5.58	5.95	6.35	6.77	7.23	7.71
	45° Elbow	3.57	3.75	3.93	4.20	4.48	4.78	5.09	5.44	5.80
	Ent. Loss	9.27	9.73	10.21	10.89	11.62	12.39	13.22	14.11	15.05
10" Duct Single Boiler	Straight Run	0.28	0.28	0.29	0.30	0.31	0.32	0.32	0.33	0.34
	90° Elbow	1.60	1.68	1.77	1.88	2.01	2.14	2.29	2.44	2.60
	45° Elbow	1.21	1.27	1.33	1.42	1.51	1.61	1.72	1.84	1.96
	Ent. Loss	3.80	3.98	4.18	4.46	4.76	5.08	5.42	5.78	6.16
12" Duct Two Boilers	Straight Run	0.35	0.37	0.38	0.41	0.43	0.46	0.49	0.52	0.55
	90° Elbow	2.80	2.93	3.08	3.28	3.50	3.74	3.99	4.25	4.54
	45° Elbow	2.13	2.23	2.34	2.50	2.67	2.85	3.04	3.24	3.46
	Ent. Loss	7.33	7.69	8.07	8.60	9.18	9.79	10.45	11.15	11.89
14" Duct Two Boilers	Straight Run	0.16	0.17	0.18	0.19	0.20	0.21	0.23	0.24	0.25
	90° Elbow	1.45	1.53	1.60	1.71	1.82	1.94	2.07	2.21	2.36
	45° Elbow	1.12	1.18	1.24	1.32	1.41	1.50	1.60	1.71	1.83
	Ent. Loss	3.95	4.15	4.35	4.64	4.95	5.29	5.64	6.02	6.42
16" Duct Three Boilers	Straight Run	0.18	0.19	0.19	0.21	0.22	0.23	0.25	0.27	0.28
	90° Elbow	1.90	1.99	2.09	2.23	2.38	2.54	2.71	2.89	3.08
	45° Elbow	1.49	1.56	1.64	1.74	1.86	1.99	2.12	2.26	2.41
	Ent. Loss	5.21	5.47	5.74	6.12	6.53	6.97	7.44	7.94	8.47
18" Duct Three Boilers	Straight Run	0.10	0.10	0.11	0.11	0.12	0.13	0.14	0.15	0.16
	90° Elbow	1.16	1.22	1.28	1.37	1.46	1.56	1.66	1.77	1.89
	45° Elbow	0.92	0.96	1.01	1.08	1.15	1.23	1.31	1.40	1.49
	Ent. Loss	3.26	3.42	3.58	3.82	4.08	4.35	4.64	4.95	5.29
18" Duct Four Boilers	Straight Run	0.17	0.18	0.19	0.20	0.21	0.22	0.24	0.25	0.27
	90° Elbow	2.07	2.17	2.28	2.43	2.59	2.77	2.95	3.15	3.36
	45° Elbow	1.63	1.71	1.80	1.92	2.04	2.18	2.33	2.48	2.65
	Ent. Loss	5.79	6.07	6.37	6.80	7.25	7.74	8.25	8.81	9.40
20" Duct Four Boilers	Straight Run	0.10	0.11	0.11	0.12	0.12	0.13	0.14	0.15	0.16
	90° Elbow	1.30	1.37	1.44	1.53	1.63	1.74	1.86	1.98	2.12
	45° Elbow	1.03	1.08	1.13	1.21	1.29	1.37	1.46	1.56	1.67
	Ent. Loss	3.80	3.98	4.18	4.46	4.76	5.08	5.42	5.78	6.16

NOTES: 1) Calculation assumes 700 scfm per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)
3) Units for "Elbows" and "Ent. Loss" are (equivalent feet / item)

Table 2g:
Ducted Combustion Air Duct Pressure Drop for BMK 6000 MMBTU Boiler

		Outside Air Temperature (°F)								
Inlet Duct & No. Boilers	**Duct Section Type**	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
14" Duct Single Boiler	Straight Run	0.16	0.17	0.18	0.19	0.20	0.22	0.23	0.25	0.26
	90° Elbow	1.49	1.57	1.64	1.75	1.87	2.00	2.13	2.27	2.42
	45° Elbow	1.16	1.22	1.28	1.36	1.46	1.55	1.66	1.77	1.89
	Ent. Loss	3.95	4.15	4.35	4.64	4.95	5.29	5.64	6.02	6.42
16" Duct Single Boiler	Straight Run	0.08	0.09	0.09	0.10	0.10	0.11	0.12	0.13	0.13
	90° Elbow	0.82	0.86	0.91	0.97	1.03	1.10	1.18	1.25	1.34
	45° Elbow	0.64	0.67	0.71	0.76	0.81	0.86	0.92	0.98	1.04
	Ent. Loss	2.32	2.43	2.55	2.72	2.90	3.10	3.31	3.53	3.76
18" Duct Two Boilers	Straight Run	0.17	0.18	0.19	0.20	0.21	0.23	0.24	0.26	0.28
	90° Elbow	1.96	2.05	2.15	2.30	2.45	2.62	2.79	2.98	3.18
	45° Elbow	1.53	1.60	1.68	1.79	1.91	2.04	2.18	2.32	2.48
	Ent. Loss	5.79	6.07	6.37	6.80	7.25	7.74	8.25	8.81	9.40
20" Duct Two Boilers	Straight Run	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.16
	90° Elbow	1.23	1.29	1.35	1.44	1.54	1.64	1.75	1.87	1.99
	45° Elbow	0.96	1.00	1.05	1.12	1.20	1.28	1.36	1.46	1.55
	Ent. Loss	3.80	3.98	4.18	4.46	4.76	5.08	5.42	5.78	6.16
22" Duct Three Boilers	Straight Run	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.22
	90° Elbow	1.80	1.89	1.99	2.12	2.26	2.41	2.57	2.75	2.93
	45° Elbow	1.41	1.47	1.55	1.65	1.76	1.88	2.00	2.14	2.28
	Ent. Loss	5.84	6.12	6.43	6.85	7.31	7.80	8.32	8.88	9.47
24" Duct Three Boilers	Straight Run	0.09	0.09	0.10	0.10	0.11	0.12	0.12	0.13	0.14
	90° Elbow	1.22	1.28	1.34	1.43	1.53	1.63	1.74	1.85	1.98
	45° Elbow	0.95	1.00	1.04	1.11	1.19	1.27	1.35	1.44	1.54
	Ent. Loss	4.12	4.32	4.54	4.84	5.16	5.51	5.88	6.27	6.69
24" Duct Four Boilers	Straight Run	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.23	0.24
	90° Elbow	2.17	2.27	2.39	2.54	2.71	2.90	3.09	3.30	3.52
	45° Elbow	1.69	1.77	1.86	1.98	2.11	2.25	2.40	2.57	2.74
	Ent. Loss	7.33	7.69	8.07	8.60	9.18	9.79	10.45	11.15	11.89
26" Duct Four Boilers	Straight Run	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.16
	90° Elbow	1.50	1.57	1.65	1.76	1.88	2.01	2.14	2.28	2.44
	45° Elbow	1.17	1.23	1.29	1.37	1.46	1.56	1.67	1.78	1.90
	Ent. Loss	5.32	5.58	5.86	6.25	6.66	7.11	7.59	5.78	8.63

NOTES: 1) Calculation assumes 1200 scfm per boiler at full fire rate
2) Units for "Straight Run" pressure drop values are (eq. ft. / foot)
3) Units for "Elbows" and "Ent. Loss" are (equivilent feet / item)

Table 3a- Part 1:
Gross Natural Draft (Inch W.C.) for BMK 1000 & BMK 750 Low NOx Boilers

	Outside Air Temperature (°F)								
Stack Height (ft)	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
5	0.024	0.022	0.021	0.018	0.016	0.014	0.011	0.009	0.007
10	0.048	0.045	0.041	0.037	0.032	0.028	0.023	0.018	0.014
15	0.072	0.067	0.062	0.055	0.048	0.041	0.034	0.028	0.021
20	0.096	0.089	0.083	0.073	0.064	0.055	0.046	0.037	0.028
25	0.120	0.112	0.103	0.092	0.080	0.069	0.057	0.046	0.034
30	0.144	0.134	0.124	0.110	0.096	0.083	0.069	0.055	0.041
35	0.168	0.156	0.144	0.128	0.112	0.096	0.080	0.064	0.048
40	0.193	0.179	0.165	0.147	0.128	0.110	0.092	0.073	0.055
45	0.217	0.201	0.186	0.165	0.144	0.124	0.103	0.083	0.062
50	0.241	0.223	0.206	0.183	0.160	0.138	0.115	0.092	0.069
75	0.361	0.335	0.309	0.275	0.241	0.206	0.172	0.138	0.103
100	0.481	0.447	0.413	0.367	0.321	0.275	0.229	0.183	0.138
125	0.602	0.559	0.516	0.458	0.401	0.344	0.287	0.229	0.172
150	0.722	0.670	0.619	0.550	0.481	0.413	0.344	0.275	0.206
175	0.842	0.782	0.722	0.642	0.562	0.481	0.401	0.321	0.241
200	0.963	0.894	0.825	0.734	0.642	0.550	0.458	0.367	0.275

Table 3a-Part 2:
Gross Natural Draft (Eq. Ft.) for BMK 1000 & BMK 750 Low NOx Boilers

	Outside Air Temperature (°F)								
Stack Height (ft)	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
5	4.1	3.8	3.5	3.2	2.8	2.4	2.0	1.6	1.2
10	8.3	7.7	7.1	6.3	5.5	4.7	3.9	3.2	2.4
15	12.4	11.5	10.6	9.5	8.3	7.1	5.9	4.7	3.5
20	16.6	15.4	14.2	12.6	11.0	9.5	7.9	6.3	4.7
25	20.7	19.2	17.7	15.8	13.8	11.8	9.9	7.9	5.9
30	24.8	23.1	21.3	18.9	16.6	14.2	11.8	9.5	7.1
35	29.0	26.9	24.8	22.1	19.3	16.6	13.8	11.0	8.3
40	33.1	30.8	28.4	25.2	22.1	18.9	15.8	12.6	9.5
45	37.3	34.6	31.9	28.4	24.8	21.3	17.7	14.2	10.6
50	41.4	38.4	35.5	31.5	27.6	23.7	19.7	15.8	11.8
75	62.1	57.7	53.2	47.3	41.4	35.5	29.6	23.7	17.7
100	82.8	76.9	71.0	63.1	55.2	47.3	39.4	31.5	23.7
125	103.5	96.1	88.7	78.9	69.0	59.1	49.3	39.4	29.6
150	124.2	115.3	106.4	94.6	82.8	71.0	59.1	47.3	35.5
175	144.9	134.5	124.2	110.4	96.6	82.8	69.0	55.2	41.4
200	165.6	153.8	141.9	126.2	110.4	94.6	78.9	63.1	47.3

Note: Based on 160°F to 180°F Boiler Water

Table 3b-Part 1:

Gross Natural Draft (Inch W.C.) for BMK 1500, BMK 2000, BMK 2500, BMK 3000 Low NOx Boilers

	Outside Air Temperature (°F)								
Stack Height (ft)	**-30°F**	**-15°F**	**0°F**	**20°F**	**40°F**	**60°F**	**80°F**	**100°F**	**120°F**
5	0.024	0.022	0.021	0.018	0.016	0.014	0.011	0.009	0.007
10	0.048	0.045	0.041	0.037	0.032	0.028	0.023	0.018	0.014
15	0.072	0.067	0.062	0.055	0.048	0.041	0.034	0.028	0.021
20	0.096	0.089	0.083	0.073	0.064	0.055	0.046	0.037	0.028
25	0.120	0.112	0.103	0.092	0.080	0.069	0.057	0.046	0.034
30	0.144	0.134	0.124	0.110	0.096	0.083	0.069	0.055	0.041
35	0.168	0.156	0.144	0.128	0.112	0.096	0.080	0.064	0.048
40	0.193	0.179	0.165	0.147	0.128	0.110	0.092	0.073	0.055
45	0.217	0.201	0.186	0.165	0.144	0.124	0.103	0.083	0.062
50	0.241	0.223	0.206	0.183	0.160	0.138	0.115	0.092	0.069
75	0.361	0.335	0.309	0.275	0.241	0.206	0.172	0.138	0.103
100	0.481	0.447	0.413	0.367	0.321	0.275	0.229	0.183	0.138
125	0.602	0.559	0.516	0.458	0.401	0.344	0.287	0.229	0.172
150	0.722	0.670	0.619	0.550	0.481	0.413	0.344	0.275	0.206
175	0.842	0.782	0.722	0.642	0.562	0.481	0.401	0.321	0.241
200	0.963	0.894	0.825	0.734	0.642	0.550	0.458	0.367	0.275

Table 3b-Part 2:

Gross Natural Draft (Eq. Ft.) for BMK 1500, BMK 2000, BMK 2500, BMK 3000 Low NOx Boilers

	Outside Air Temperature (°F)								
Stack Height (ft)	**-30°F**	**-15°F**	**0°F**	**20°F**	**40°F**	**60°F**	**80°F**	**100°F**	**120°F**
5	4.1	3.8	3.5	3.2	2.8	2.4	2.0	1.6	1.2
10	8.3	7.7	7.1	6.3	5.5	4.7	3.9	3.2	2.4
15	12.4	11.5	10.6	9.5	8.3	7.1	5.9	4.7	3.5
20	16.6	15.4	14.2	12.6	11.0	9.5	7.9	6.3	4.7
25	20.7	19.2	17.7	15.8	13.8	11.8	9.9	7.9	5.9
30	24.8	23.1	21.3	18.9	16.6	14.2	11.8	9.5	7.1
35	29.0	26.9	24.8	22.1	19.3	16.6	13.8	11.0	8.3
40	33.1	30.8	28.4	25.2	22.1	18.9	15.8	12.6	9.5
45	37.3	34.6	31.9	28.4	24.8	21.3	17.7	14.2	10.6
50	41.4	38.4	35.5	31.5	27.6	23.7	19.7	15.8	11.8
75	62.1	57.7	53.2	47.3	41.4	35.5	29.6	23.7	17.7
100	82.8	76.9	71.0	63.1	55.2	47.3	39.4	31.5	23.7
125	103.5	96.1	88.7	78.9	69.0	59.1	49.3	39.4	29.6
150	124.2	115.3	106.4	94.6	82.8	71.0	59.1	47.3	35.5
175	144.9	134.5	124.2	110.4	96.6	82.8	69.0	55.2	41.4
200	165.6	153.8	141.9	126.2	110.4	94.6	78.9	63.1	47.3

Note: Based on 160 °F to 180 °F

Table 3c-Part 1:
Gross Natural Draft (Inch W.C.) for BMK 6000 Low NOx Boilers

	Outside Air Design Temperature (°F)								
Stack Height (ft)	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
5	0.024	0.022	0.021	0.018	0.016	0.014	0.011	0.009	0.007
10	0.048	0.045	0.041	0.037	0.032	0.028	0.023	0.018	0.014
15	0.072	0.067	0.062	0.055	0.048	0.041	0.034	0.028	0.021
20	0.096	0.089	0.083	0.073	0.064	0.055	0.046	0.037	0.028
25	0.120	0.112	0.103	0.092	0.080	0.069	0.057	0.046	0.034
30	0.144	0.134	0.124	0.110	0.096	0.083	0.069	0.055	0.041
35	0.168	0.156	0.144	0.128	0.112	0.096	0.080	0.064	0.048
40	0.193	0.179	0.165	0.147	0.128	0.110	0.092	0.073	0.055
45	0.217	0.201	0.186	0.165	0.144	0.124	0.103	0.083	0.062
50	0.241	0.223	0.206	0.183	0.160	0.138	0.115	0.092	0.069
75	0.361	0.335	0.309	0.275	0.241	0.206	0.172	0.138	0.103
100	0.481	0.447	0.413	0.367	0.321	0.275	0.229	0.183	0.138
125	0.602	0.559	0.516	0.458	0.401	0.344	0.287	0.229	0.172
150	0.722	0.670	0.619	0.550	0.481	0.413	0.344	0.275	0.206
175	0.842	0.782	0.722	0.642	0.562	0.481	0.401	0.321	0.241
200	0.963	0.894	0.825	0.734	0.642	0.550	0.458	0.367	0.275

Table 3c-Part 2:
Gross Natural Draft (Eq. Ft.) for BMK 6000 Low NOx Boilers

	Outside Air Temperature (°F)								
Stack Height (ft)	**-30 °F**	**-15 °F**	**0 °F**	**20 °F**	**40 °F**	**60 °F**	**80 °F**	**100 °F**	**120 °F**
5	4.1	3.8	3.5	3.2	2.8	2.4	2.0	1.6	1.2
10	8.3	7.7	7.1	6.3	5.5	4.7	3.9	3.2	2.4
15	12.4	11.5	10.6	9.5	8.3	7.1	5.9	4.7	3.5
20	16.6	15.4	14.2	12.6	11.0	9.5	7.9	6.3	4.7
25	20.7	19.2	17.7	15.8	13.8	11.8	9.9	7.9	5.9
30	24.8	23.1	21.3	18.9	16.6	14.2	11.8	9.5	7.1
35	29.0	26.9	24.8	22.1	19.3	16.6	13.8	11.0	8.3
40	33.1	30.8	28.4	25.2	22.1	18.9	15.8	12.6	9.5
45	37.3	34.6	31.9	28.4	24.8	21.3	17.7	14.2	10.6
50	41.4	38.4	35.5	31.5	27.6	23.7	19.7	15.8	11.8
75	62.1	57.7	53.2	47.3	41.4	35.5	29.6	23.7	17.7
100	82.8	76.9	71.0	63.1	55.2	47.3	39.4	31.5	23.7
125	103.5	96.1	88.7	78.9	69.0	59.1	49.3	39.4	29.6
150	124.2	115.3	106.4	94.6	82.8	71.0	59.1	47.3	35.5
175	144.9	134.5	124.2	110.4	96.6	82.8	69.0	55.2	41.4
200	165.6	153.8	141.9	126.2	110.4	94.6	78.9	63.1	47.3

Note: Based on 160°F to 180°F Boiler Water

Table 4: Altitude Correction

Site Elevation (feet above sea level)	Altitude Correction Factor (CF)
0	1
500	0.982
1000	0.964
1500	0.947
2000	0.930
2500	0.913
3000	0.896
3500	0.880
4000	0.864
4500	0.848
5000	0.832
5500	0.817
6000	0.801
6500	0.787
7000	0.772
7500	0.758
8000	0.743
8500	0.729
9000	0.715
9500	0.701
10000	0.688

Table 5: Round Duct of Identical Pressure Drop to Rectangular Duct

Adjacent Side of Duct (in.)	Side of Rectangular Duct (in.)									
	6	8	10	12	14	16	18	20	22	24
6	6.6									
8	7.6	8.7								
10	8.4	9.8	10.9							
12	9.1	10.7	12	13.1						
14	9.8	11.5	12.9	14.2	15.3					
16	10.4	12.2	13.7	15.1	16.4	17.5				
18	11	12.9	14.5	16	17.3	18.5	19.7			
20	11.5	13.5	15.2	16.8	18.2	19.5	20.7	21.9		
22	12	14.1	15.9	17.6	19.1	20.4	21.7	22.9	24	
24	12.4	14.6	16.5	18.3	19.9	21.3	22.7	23.9	25.1	26.2

Reference:

1. *National Fuel Gas Code, 2006 edition*, American National Standards Institute, Inc (ANSI Z223.1-2006) and National Fire Protection Association (NFPA54-2006)
2. CSA B149.1 (For Canada installations)

Change Log:

Date	Description	Changed By
11/19/2013	Rev R: Changed references to “Sealed combustion” to “ducted combustion air”. Also added section 1.13 “Acceptable Pressure Range” to page 14.	Curtis Harvey
12/03/2013	Rev S: Corrected calculation in section 1.21.1 to read: 2 X 13.11 = 26.22	Chris Blair

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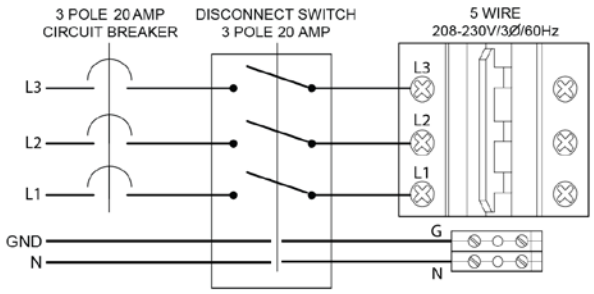
ELECTRICAL POWER GUIDE

Natural Gas, Propane Gas, or Dual Fuel Fired Modulating, Condensing Boilers

For models:

BMK 750 to BMK 6000

Benchmark Series
Gas-Fired Boilers



Benchmark 2500/3000 Power Wiring

Last Update: 11/08/2013

Technical Support:
(Mon–Fri, 8am-5pm EST)
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GENERAL

Benchmark (BMK) Gas Fired Boilers are fully factory wired packaged units which require simple external power wiring as part of the installation (Diagram 1). This technical guide is intended to help designers provide electrical power wiring (line voltage) to Benchmark units. Control wiring details are provided in other publications, depending upon unit application. This document is intended only as a guide and therefore cannot include all possible alternatives, or unit applications. In order to comply with all codes and authorities having jurisdiction, designers and installers must plan the electrical wiring carefully and execute the installation completely. Emergency shutoffs, fusible fire switches, break glass stations, and other electrical requirements should be considered and installed whenever necessary.

Boiler Electrical Requirements

With the exception of BMK 2500, BMK 3000, and BMK 6000 models, Benchmark boilers require 120V/1Ø/60 Hz electrical power. BMK 2500, BMK 3000, and BMK 6000 models require 3Ø power and can be ordered with either one of the following power options:

BMK 2500 - 3000	BMK 6000
208-230V/3Ø/60 Hz @ 20 amps	208-230V/3Ø/60 Hz @ 30 amps
460V/3Ø/60 Hz @ 15 amps	460V/3Ø/60 Hz @ 20 amps

For all Benchmark models, the power distribution block for field wiring connections (Diagram 2) is located in the upper right corner behind the unit front panel. All copper wire must be connected to the power distribution block. For all 1Ø Benchmark models, the minimum supply voltage to the unit is 110 VAC. For 3Ø Benchmark 2500 - 6000 models, the minimum supply voltages to the unit are 190 VAC for 208-230/3Ø/60 Hz and 415 VAC for 460/3Ø/60 Hz. Lower voltages will result in increased wear and premature failure of the blower motor. Wire size and type should be made per the National Electrical Code based on length and load.

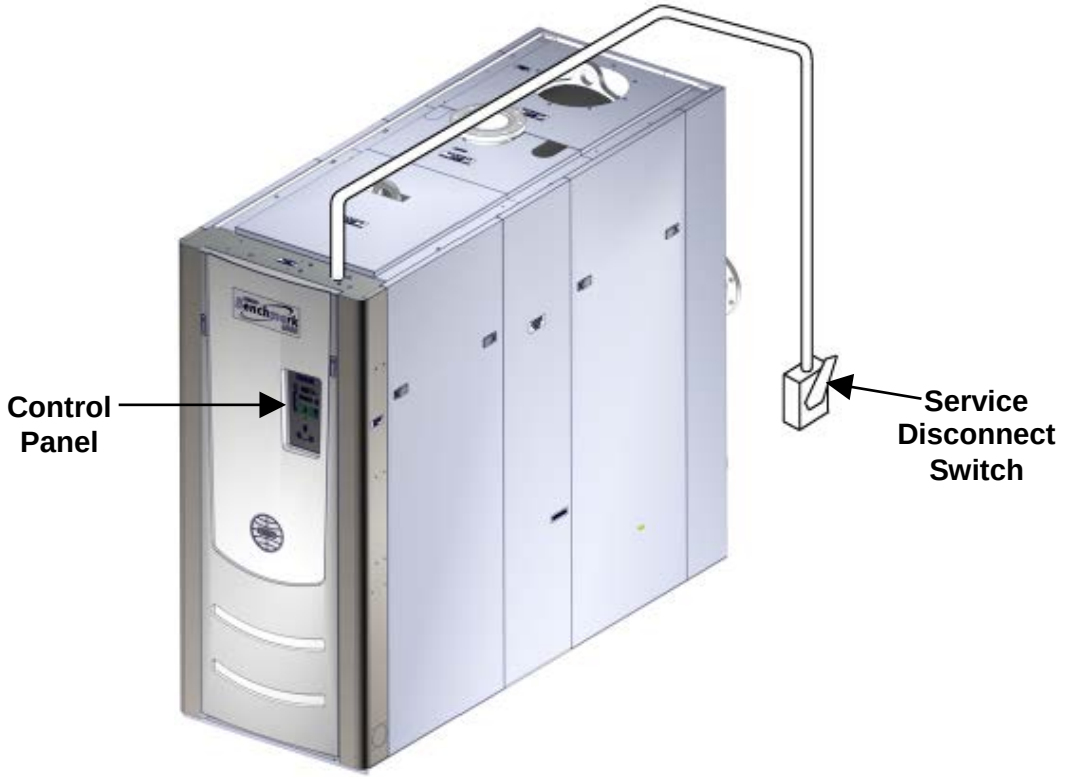

Diagram 1: Service Switch Typical Location

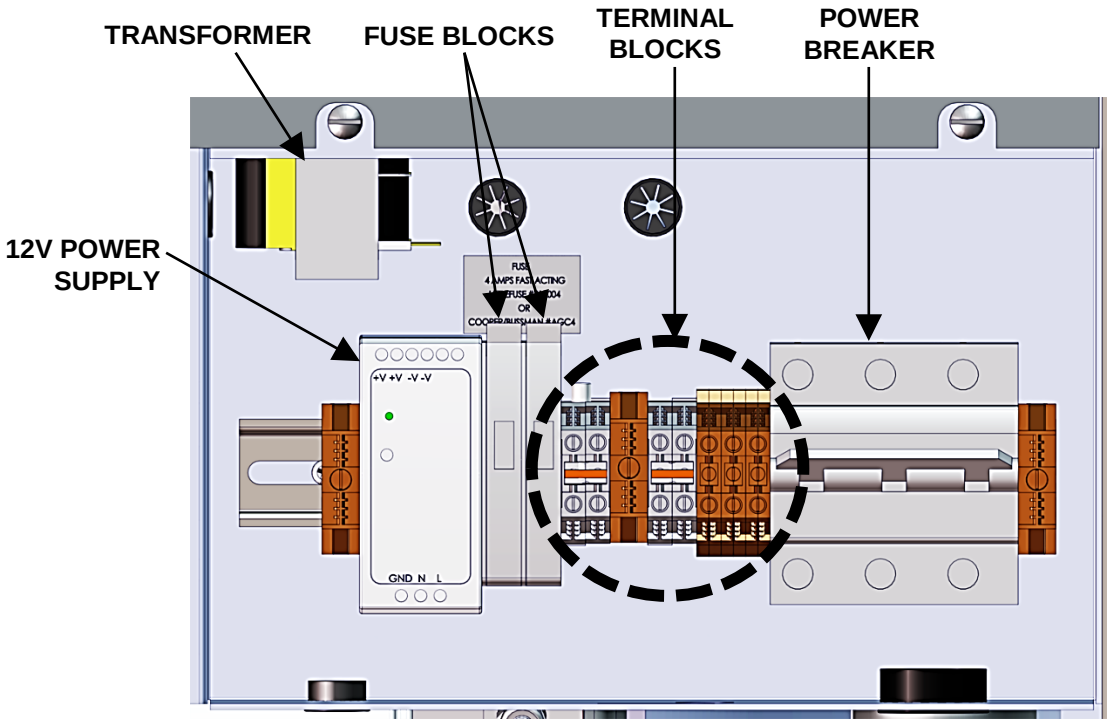

Diagram 2: Power Box Connections for BMK 1500/2000/2500/3000/6000

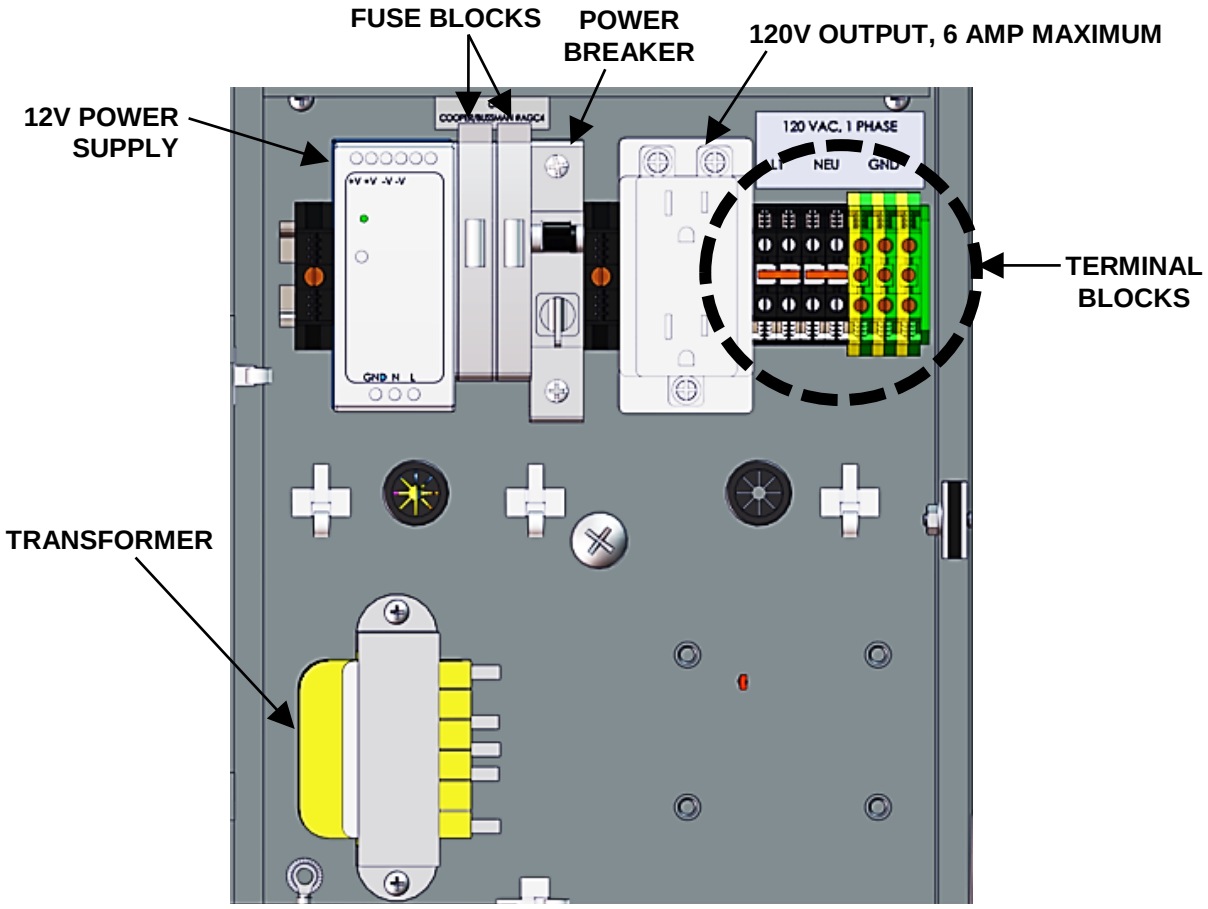

Diagram 3: Power Box Connections for BMK 750/1000

Provisions for Service

Designers must provide emergency shutoffs and other devices to satisfy electrical codes. It is also recommended to provide an electrical shutoff disconnect switch of suitable load carrying characteristics on or near each BMK boiler. No electrical boxes or field components should be mounted to the surface of the boiler or where they would interfere with the removal of the side or top panels for maintenance. The service disconnect switch should be mounted near the unit, as illustrated in Diagram 1. Wiring conduit, EMT, or other wiring paths should not be secured to the unit, but supported externally. Electricians should be instructed as to where the wiring conduit should be located, such as away from the relief valve discharge, drains, etc. All electrical conduit and hardware should be installed so that it does not interfere with the removal of any covers, inhibit service or maintenance, or prevent access between the unit and walls or another unit.

Boiler Wiring

A dedicated protected circuit should be provided from the power source to the boiler. No other electrical devices should be permanently wired on the same circuit. An emergency switch (electrical shutoff) must be in series with the power to the unit. For applicable wiring connections, refer to the following Diagrams:

- Diagram 4: 120V/1Ø/60 Hz @ 20 amps (BMK 750/1000/1500/2000)
- Diagram 5: 208-230/3Ø/60 Hz @ 20 amps (BMK 2500/3000)
- Diagram 6: 208/3Ø/60 Hz @ 30 amps (BMK 6000)
- Diagram 7: 460/3Ø/60 Hz @ 15 amps (BMK 2500/3000)
- Diagram 8: 460/3Ø/60 Hz @ 20 amps (BMK 6000)

Multiple Unit Wiring

Whenever multiple units are installed within the same mechanical spaces, electrical code requirements call for a single electrical shutoff for emergency use. It is the responsibility of the electrical designer to comply with local codes and regulations affecting an individual installation.

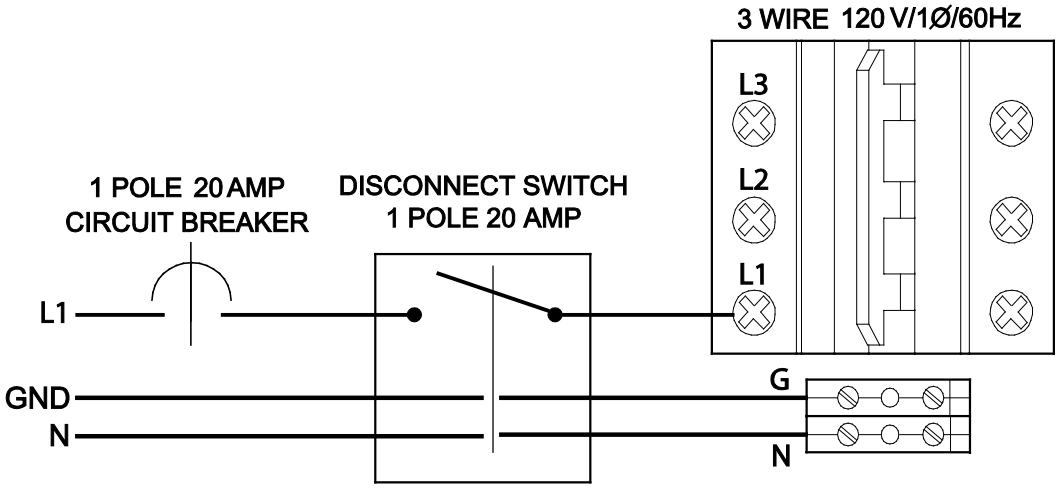

Diagram 4: BMK 750/1000/1500/2000: 120VAC/1Ø/60 Hz Wiring Schematic

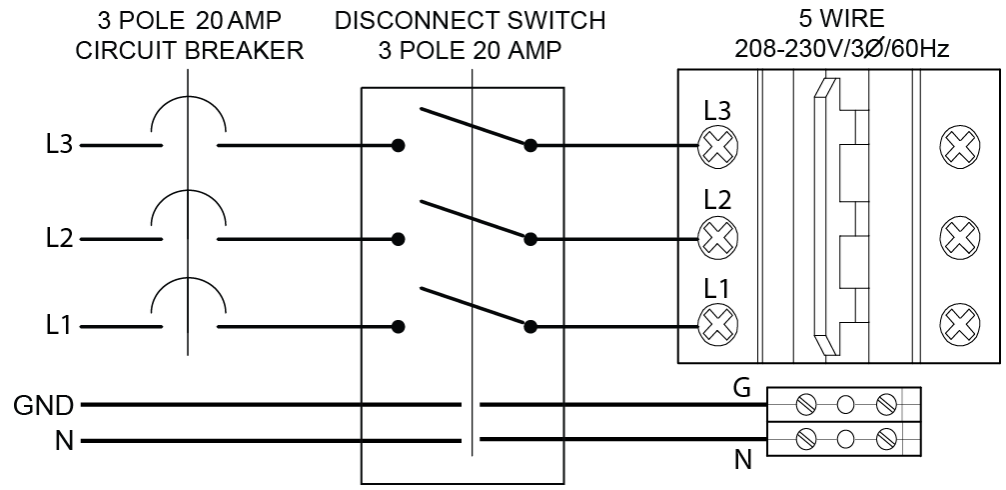

Diagram 5: BMK 2500/3000: 208-230/3∅/60 Wiring Schematic- 5 Wire

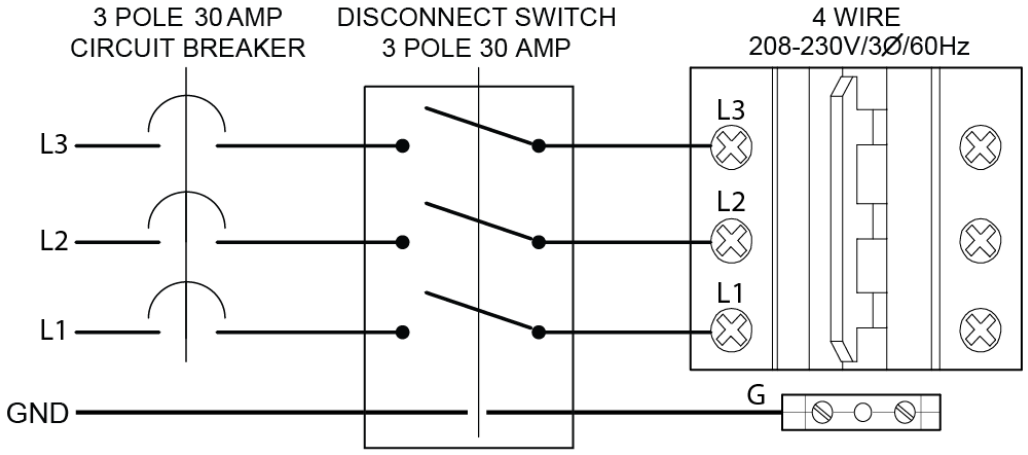

Diagram 6: BMK 6000: 208/3∅/60 Wiring Schematic- 4 Wire

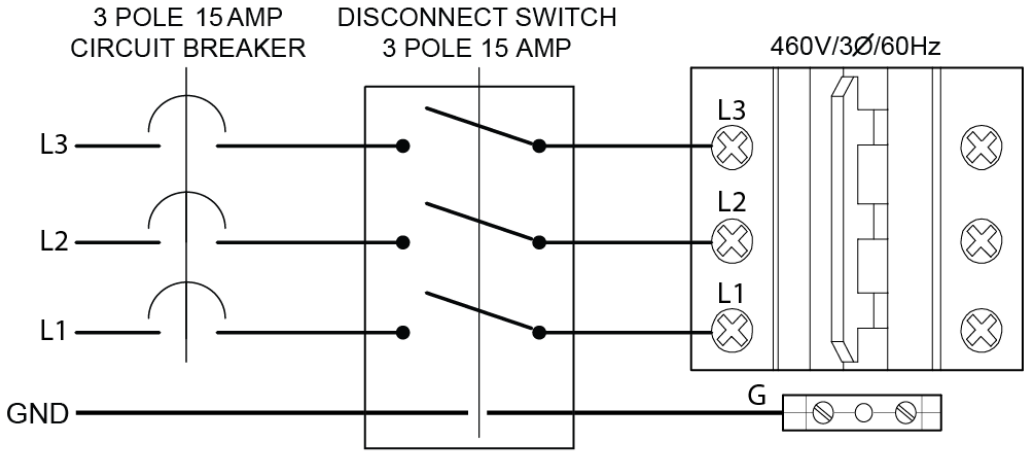

Diagram 7: BMK 2500/3000: 460/3∅/60 Wiring Schematic- 4 Wire

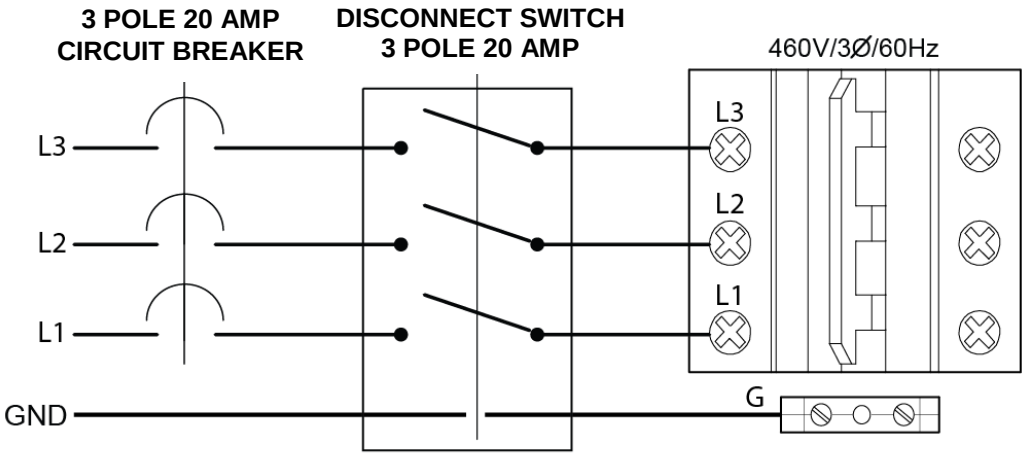

Diagram 8: BMK 6000: 460/3∅/60 Wiring Schematic- 4 Wire

Change Log

Date	Description	Changed By
05/15/2013	Rev G: Changed all references to BMK 6000 208-230 volts to 208 volts only, pages 3 & 4.	Chris Blair
09/12/2013	Rev H: Removed all ref. to BMK 1.5, 2.0, 3.0. Added 750/1000/1500/2500 refs. Removed 1.5/2.0 wiring diag. and added 750/1000 wiring diag. Revised elec. safety switch loc. drawing to BMK6000.	Curtis Harvey
11/08/2013	Rev I: Changed 460V BMK 6000 from 15A to 20A and added Diagram 8 wiring and table column.	Curtis

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